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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 50 OCTOBER, 1943 No. 4

SOME CHANGES MADE IN THE CARE OF CIVILIAN PATIENTS DUE TO WAR CONDITIONS*†

By CYRUS C. STURGIS, M.D.

ANN ARBOR, MICHIGAN

FIRST let me thank the sponsors of this Memorial for the opportunity which they have afforded me, to give this lecture in honor of Preston M. Hickey, my late friend, wise counselor, and faculty colleague at the University of Michigan. There are several reasons why this invitation was immediately and gladly accepted, and among them are some personal ones to which I wish to devote special attention. The first is that I am indebted to Dr. Hickey for his early and continuous support of my candidacy for the position which I have occupied since coming to Michigan. It came about in this way. In July, 1925, Dr. Lawrence Reynolds introduced me to Dr. Hickey who was then in New York en route to Europe for the summer. Fortunately for me, I apparently met with his approval, for later, when my name was proposed to the faculty of the University, he gave the nomination his cordial and enthusiastic support. For this I shall be forever grateful, for with his help, I was placed in a position which I have occupied with much happiness for the past sixteen years.

The second reason why I have a special interest in paying tribute to Dr. Hickey is to record publicly his great practical contribution to the establishment of the Thomas Henry Simpson Memorial Institute of the University of Michigan. His rôle with reference to this is little known even by some of his intimate associates. Chance perhaps played a part in his association with Mr. Henry Slyfield as a close friend and a member of the same undergraduate fraternity at the University of Michigan. But this was to be an important friendship for the University because when Mrs. Thomas Henry Simpson decided to present a substantial sum to the University for the establishment of an institute for the study of pernicious anemia, she quite naturally sought the advice of Mr. Slyfield who was then, as he is now, her legal adviser. It is readily understandable that as the initial move, upon which so much depended, he should discuss the matter informally with Dr. Hickey, who had been his close friend for many years and on whose judgment in such matters he could place absolute reliance. From the moment of their first interview, Dr. Hickey made the Institute one of his major interests. He was concerned with its functions, its relationship to the Medical School, the Hospital, and the University, and the practical planning and actual arrangement of the

* From the Thomas Henry Simpson Memorial Institute for Medical Research, University of Michigan.

† The Preston M. Hickey Memorial Lecture, presented before the Detroit Roentgen Ray and Radium Society and the Wayne County Medical Society, April 5, 1943.

building and its equipment. Consequently, when I began my work in Michigan, it was my privilege to enter a beautifully planned and perfectly equipped building which I am frank to acknowledge, surpassed anything which I could have accomplished. For this I have Dr. Hickey to thank for he was the faculty member who had almost the sole responsibility in these affairs. On innumerable occasions, since my association with the University, I am reminded in one way or another of his consummate skill in many matters, his outstanding flair for planning, and his quiet and unassuming, but highly effective method of accomplishment.

And finally, I should like to add a statement concerning my own happy personal relations with Dr. Hickey which were always exceedingly pleasant and cordial. His absolute honesty, his sympathetic and warm interest, his own disinterestedness as far as personal gain was concerned, his inherent and genuine anxiousness to assist other persons,—these, and many other fine characteristics, all contributed to make one, younger in years, on intimate acquaintance, refer to him naturally and reverently, as "Pop" Hickey. I can see him now, as I sought his advice on some problem, which was not infrequent. There he stood, his kindly face directed somewhat downward in order to permit him to peer over his glasses, a perilously short cigarette stub between his thumb and forefinger, perhaps a few stray ashes on his vest, and a composite facial expression which seemed to say "sit down, let us talk this matter over, your troubles will interest rather than bore me, perhaps I can help you." In any event, after a sympathetic audience, there then followed sometimes cryptic, but always sage, advice. And hence, I salute the memory of a sincere friend, a pioneer and outstanding roentgenologist, teacher and physician, and withal a great and noble man.

But now let me turn to my medical presentation for the evening. I hope that you will consider my title an appropriate one. It is a subject in which Dr. Hickey was deeply interested, for throughout his entire association with the practice of medicine, he played an important rôle in assigning the proper values to various laboratory procedures and fostering a rational attitude toward their rightful place in clinical medicine. Furthermore, it is a timely topic because, early in the present world wide conflict, it became apparent that physicians who did not enter the Army would be confronted with an emergency situation at home which would require special measures. It means, for example, that a physician will be responsible for a great many more patients, and, at least in hospitals, that patients will be cared for by doctors who are young both in years and in experience in clinical medicine. In other words, the situation to be met is the care of an increased number of patients with a smaller staff, and in general one with less training. After careful consideration, a plan was devised at the University Hospital whereby a certain minimum number of diagnostic procedures would be performed on all patients regardless of their complaints, who were admitted to the in-patient or out-patient departments of the hospital. In this way, it was hoped that automatically a certain number of important disease conditions, some of which are relatively common, would be detected almost routinely, regardless of the press of duties and scarcity of physicians.

Our preliminary studies have been so revealing and gratifying that the question now arises, should not all patients hereafter, in civil life, be given the same type of examination? In other words, if a person comes to any physician for an examination, regardless of the nature of his complaints, should not a certain minimum number of special tests be carried out? And, if necessary, should not some arrangement be made whereby any physician can obtain such a service at a minimum cost to the patient?

With the amazing growth of highly de-

veloped specialism—and it should continue to thrive for there is much to be said in its favor—it becomes necessary to institute certain measures to protect patients against some of its dangers. As an example of one of its hazards, let me cite the hypothetical case of a patient who develops some aches and pains, perhaps due to senescent changes which cause an osteoarthritis, and on his own initiative decides to have a tonsillectomy because a relative or an acquaintance who suffered from a similar complaint benefited by such a procedure. Consequently, he presents himself to an otolaryngologist who after a brief examination of only the nose and throat agrees to the operation, and the following morning performs this therapeutic measure. Consider what may have happened. He may have operated upon a patient who in addition had latent syphilis, pulmonary tuberculosis, an anemia, pelvic inflammatory disease, an early cancer of the breast, uterus, or the stomach, and nephritis or diabetes, or some other major disease. Not only might an otolaryngologist overlook important pathological states which are not included in his main field of interest, but the same oversight might occur if the patient consulted the hematologist, ophthalmologist, dermatologist, or any other physician who restricted his interest in patients to a limited part or system of the body.

It is desirable that specialization in medicine should continue to be with us, for it enables a physician to attain a high degree of perfection in certain subdivisions of medicine which could be accomplished in no other way. But its dangers must be kept in mind constantly and dealt with effectively if our objective is to provide the best possible medical care for all of our patients.

My plea, therefore, is to confess frankly that a physician cannot take care of parts of patients, and to attempt to do so is fraught with danger. In an effort to circumvent errors at the University Hospital during the present emergency, a minimum number of diagnostic procedures are required on all patients, regardless of the nature of their complaints. In other words, a few important examinations are made obligatory, knowing that they would disclose, in a significant percentage of patients, various pathologic lesions which otherwise would be overlooked. This should be regarded as only a step in the right direction for doubtless in the future the type of preliminary examination should become more general and complete.

Before proceeding further, let me elucidate my present concepts concerning the relation of various laboratory tests to clinical medicine. My medical experience between the years 1913 and 1942 has seen the beginnings of the rational use in medicine of information derived from the laboratory, and, although we still have a considerable distance to go, praiseworthy progress has been made. There are four attitudes which one may assume, namely:

(1) A complete, and almost scornful indifference to such tests. Needless to say, a physician who so believes fails to utilize some of the most helpful diagnostic procedures in medicine and for this deserves severe censure, as he is not providing the proper attention for his patients.

(2) Excessive emphasis on information from the laboratory, which leads a physician to go to the other extreme and employ all of the tests on all patients. As a result, he omits or depreciates other types of information such as might be derived from the history and physical examination. His attitude is one which subconsciously leads him to believe that a laboratory test can actually think for him. Needless to say, this position is an unwise one, which will eventually result in much more harm than good for the patient.

(3) The so-called rational attitude which means that only those laboratory procedures are employed which have very definite indications. There is much to be said for this plan for it does meet the needs of many patients. It has its shortcomings, however, and a discussion of them composes the very essence of my theme to-

night. It is this. More frequently than we suspect, laboratory tests will disclose pathologic lesions about which there is not the slightest hint or clue obtained in the history or physical examination. This may have been because the patient failed to state certain important facts, or perhaps because abnormal physical signs were not observed, but undoubtedly the most important of all is because often important pathologic changes do not produce symptoms or physical signs, especially in the early stages of the disease. In other words, significant pathologic lesions may become well established before manifestations are detected by the usual methods of examination.

(4) The most efficient plan to be followed is the one which utilizes various tests when indicated by the history, the physical examination, and the information supplied by the routine special examinations. But, in addition, such studies should be supplemented by the routine of a certain minimum number of special examinations on every single patient.

It is my intention to discuss the use and value of such tests which have been applied to all patients observed in any of the eleven divisions of our out-patient department, or when admitted to the various services as in-patients, regardless of the variety or severity of their complaints. The procedures employed routinely were as follows:

1. The serological test for syphilis.
2. Chest microfluorograms.
3. Blood examination with special reference to the frequency of anemia and the various types encountered.
4. The erythrocyte sedimentation rate.

Of course, additional information concerning patients is determined routinely in various departments. In all out-patients the body temperature, pulse rate, and respiration rate are noted. In the medical department, in addition to the routine use of tests which are discussed in this article, the body weight and blood pressure are recorded, and the urine is examined.

SEROLOGICAL TEST FOR SYPHILIS

The Wassermann reaction for syphilis was the earliest of the more complicated diagnostic tests to be applied routinely to patients. Its value has been established so that it is now considered to be an essential part of a medical examination, and one which every physician would be reluctant to forego. Every one who has practiced medicine long enough can recall with regret how, as the result of some oversight, he has failed to obtain a test for syphilis, or through a pseudo-magnanimous attitude of mind, he has waived this test as unnecessary, only to discover ultimately, to the embarrassment of all concerned, that the patient's complaints were associated with a luetic infection. Surely no one now believes that a serological test for syphilis should only be employed in selected cases in which there is a clear cut indication for it. Such a policy would most certainly result in frequently overlooking a disease condition which is communicable, congenital and one for which the withholding of efficient treatment constitutes a major therapeutic omission.

We have employed the Kahn reaction for the past fourteen years under the direction of the originator of the test, Dr. Reuben L. Kahn. Of our average of 30,000 new registrations annually, all of whom receive the test, only approximately 600, or 2 per cent, have a positive reaction. This low incidence is due to the fact that many of our patients are from rural areas in which the frequency of lues is less than in urban districts; our percentage of Negro patients is small; and blood from many of the obvious and active cases do not reach us but are sent to the official branch laboratories throughout the state.

Data relating to the rate of syphilitic infection, especially in those who are most likely to transmit it, are available from many sources. Studies in our Army show the positive tests for lues are now about 4.5 per cent per million of all personnel. Of these only 3 per cent had clinical evidence of the malady. Or, in other words, of the

first million selectees approximately 45,000 had positive or questionably positive blood tests for syphilis, and less than 1,500 of these had in addition other evidences of the disease. It is an understatement to say that if we applied the serologic test for lues *only* in those patients in whom there is clinical manifestation of the affliction, we would fail to detect the disorder in a great many cases. Doubtless there would be even more, because in an undetermined number, the indications for the test would also be overlooked.

Let me hasten to add that all serological tests for lues must be subjected to careful clinical interpretation in each instance because all positive results do not mean necessarily the presence of syphilis. It may, for example, be a surprise to some to learn that a positive test is obtained in a majority of cases in the blood of animals such as horses, cattle and sheep. Positive serological reactions are also present in the blood of 5 to 10 per cent of all cases of infectious mononucleosis. This certainly means that these procedures, regardless of the variety employed, are not specific ones for this disease. On the other hand, when a positive test is considered with the clinical data, and the reaction performed with varying degrees of heat and concentration of salt solutions, it is possible to decide, in almost every instance, whether a patient has, or has not, syphilis.

To practice medicine without such information would be to practice blindly. And finally let me re-emphasize that, despite the fact that only 2 per cent of our patients have positive serological evidence of syphilis, it must be regarded as one of the most essential tests that we have, because not only does it provide positive information which often could not be obtained in any other way, but also it is invaluable as a method of providing highly significant negative evidence. The value of any given diagnostic procedure is not always that it points its finger to any given disease which the patient may have but that it frequently gives assurance concerning the important absence of certain others. No one can practice medicine intelligently and thoroughly today without accumulating an abundance of such negative evidence in almost every patient.

MICROFLUOROGRAMS

Since my association with the practice of medicine, I have had constantly impressed upon me the importance of the superiority of the roentgen rays over the methods of physical diagnosis in detecting pathological changes in the lungs. One of my earliest medical recollections, when a first year medical student, was serving as one of the many supposedly normal subjects who were examined thoroughly for abnormal physical signs in the chest and having these findings compared with those detected by a chest roentgenogram. This was one of the earliest comparative studies made of the two methods of examination. I have no doubt that this investigation, which was in 1913, must have been published, but I do not know what the conclusions were. My guess is, however, that the clinician must have been surprised to find so many roentgen abnormalities of the lungs in so-called normal medical students, and probably somewhat astonished to become aware of the fact that they did not give physical signs. My further experience has been in association with hospitals where a special interest has been centered on the early detection of pulmonary tuberculosis, especially among the interns and nursing personnel. One matter which was indelibly impressed upon my mind was the surprising absence of physical signs in the presence of well defined and often extensive pulmonary lesions. This did not mean that the signs had been overlooked by a novice, but often by the most skilled examiner. Furthermore, additional experience has taught me that very definite evidence of pulmonary tuberculosis is detectable by the roentgenogram before even the slightest symptoms have become manifest. I am relterating these self-evident truths because, first, I cannot refrain from commenting on the fact that

it required an amazing period of time before the profession at large became aware of this, and second, if we are to detect the earliest chest lesions, at a time when they are most amenable to treatment, we must resort to the roentgen ray.

Knowing these facts, it was easy to predict when Dr. F. J. Hodges, Professor of Roentgenology at the University Hospital, secured a single anteroposterior chest roentgenogram on each new patient when admitted to the out-patient department of the hospital, during a two weeks' period, that an important number would show pulmonary lesions which otherwise would have been overlooked. The results are so decisive that it led to a grant from the W. K. Kellogg Foundation over two years ago which permitted the installation of an apparatus for securing 35 mm. microfluorograms routinely on all patients. The results have been most gratifying and I hope it will never again be necessary for me to practice medicine without this invaluable diagnostic aid. I will not attempt to analyze these results but very properly let Dr. Hodges tell his own story at a later day. I would, however, like to quote some of the conclusions which he published[1] several years ago after a routine survey of all patients admitted over a two weeks' period. At this time 1,101 patients had a single anteroposterior chest roentgenogram in 12.5 working days. Briefly, he observed no significant change in 68 per cent, a possibly significant one in 24 per cent, and an undoubtedly important one in 90, or 8 per cent, of all patients examined. His ultraconservative conclusions which, in my opinion, are too generous to the clinician, led him to consider that 14 of these latter cases were diagnostic errors. That is, patients who came to the hospital with specific complaints were examined by the clinician but a standard chest roentgenogram was not secured because the examining physician did not consider that it was necessary. The routine microfilm had, however, disclosed definite and clinically significant lesions, which had not been detected by the physician in charge. These 14 cases, or 1.5 per cent of the entire group, suffered from the following conditions:

- 4 cases of nonspecific pneumonitis.
- 5 cases of pulmonary tuberculosis (3 minimal and apical, and 1 of tuberculous pneumonia).
- 1 case of dextrocardia.
- 4 cases of neoplastic metastases of the lungs.

There were, in addition, two other helpful aspects of the information furnished by this study, namely (1) by the utilization of information derived from chest roentgenograms, the diagnosis in many cases would have been made a week earlier; and (2) highly significant negative information was made available. I do not wish to intimate that a 35 mm. film can eliminate entirely early pulmonary tuberculosis from consideration, but it can detect gross lesions and call attention to the desirability of securing additional information by means of the standard sized films.

My plea is, therefore, to reinforce the diagnostic study of all patients by a routine 35 mm. chest roentgenogram. This will undoubtedly establish the diagnosis in a significant number of patients when it would otherwise be overlooked, and in a hospital where there are many highly specialized departments to which patients are admitted directly, or in private practice where patients of their own volition apply directly to the specialist for diagnosis and treatment, the possibility of failing to recognize important pulmonary conditions is considerable.

THE BLOOD SURVEY

For a long time, I have been interested in two matters relating to blood diseases about which our contemporary information was inadequate to provide satisfactory answers. The first of these concerns the actual incidence of anemia, especially in the northern portion of the United States, and in addition, what is the relative frequency of the various types encountered. The second question is, what are the minimum data

necessary to detect the presence of an anemia and give reliable information concerning its nature?

I have thought for a long time that if an accurate and clinically applicable method could be standardized so that it was feasible to employ it in the routine study of the blood of all patients registered in the in-patient and out-patient departments of the hospital, the answer to the first question concerning the incidence of anemia could be secured. It is our belief that such methods are now available for 4 cc. of oxalated blood will provide a sufficient quantity for the necessary examination which will detect almost all types of blood disorders, and in addition, make available information concerning the sedimentation rate. With this amount of blood, obtained at the time venepuncture is done to secure the sample for the serological test for syphilis, it is possible to perform the following blood tests:

1. The hemoglobin estimation by means of the Klett-Summerson photoelectric colorimeter, standardized by the Van Slyke oxygen capacity method, so that 100 per cent is equivalent to 15.6 grams per 100 cc.
2. Estimation of the hematocrit reading by centrifugation of the oxalated blood in the same tube.
3. Calculation of the mean corpuscular hemoglobin concentration by means of the hemoglobin and hematocrit readings, and expression of the results in terms of normal by employing the saturation index.
4. A determination of the sedimentation rate per hour by the use of the Wintrobe hematocrit tube.

Such tests give valuable and accurate information, as follows: The hemoglobin determination by this highly satisfactory technique, indicates very precisely the presence or absence of an anemia. The mean corpuscular hemoglobin concentration and the saturation index enables one to distinguish accurately between the hypochromic anemias, on the one hand, and the normochromic or "hyperchromic," on the other. The former is the type commonly encountered and is almost always due to an iron deficiency. The latter may result from a variety of causes, including nutritional deficiency, infection, cancer, nephritis and pernicious anemia. The sedimentation rate gives valuable and reliable information relating to the presence and intensity of infection or tissue destruction in the body.

Incidence and Nature of Anemia Encountered. In order to determine the importance of routine blood examinations, a two weeks' survey was carried out at the University Hospital from August 21 to September 4, 1942. At this time an attempt was made to study the blood of all new patients who were admitted to the hospital and the out-patient departments. This excluded children, patients registered at the Simpson Memorial Institute, and those not seen at the Registration Office, as it was then not possible to include them in the survey. A total of 734 specimens of blood were examined.

As the results of the trial period were so gratifying as demonstrated by the obviously important diagnostic information revealed by the examination, it was installed as a permanent procedure on December 1, 1942, and hence has now been in operation for seven months.

Incidence and Variety of Anemia Encountered in the Routine Examination of the Blood. There are no figures available, based upon large scale investigations, which give reliable information concerning the actual incidence of the various forms of anemia in this area of the United States. Certain information, however, suggested strongly that it is much more prevalent than one would suspect. For example, Bethell, Gardiner and MacKinnon,[2] found that 54 per cent of the presumably healthy pregnant women who came to the obstetric out-patient department of the University Hospital had an anemia which was greater than the physiological variety known to occur constantly in that state. Of these, 27 per cent were of the hypochromic type due to an iron deficiency; 15 per cent of the macrocytic variety probably associated with a deficient amount of protein in the diet; and

in 12 per cent it was attributed to both causes.

From clinical experience, one can state accurately that the most common form of anemia in this vicinity is the hypochromic, microcytic type which is almost invariably due to a deficiency of iron in the body. Furthermore, it is clear that the most frequent cause of this is chronic hemorrhage. In the male this is most likely to result from some lesion in the gastrointestinal tract, such as cancer of the esophagus, stomach, or large bowel, from peptic ulcer, chronic ulcerative colitis, esophageal varices resulting from cirrhosis of the liver, or hemorrhoids. These are likewise important causes in the female, but they are surpassed in importance in this sex by uterine bleeding. Such an anemia would be indicated by the methods employed in the routine blood survey, by a mean corpuscular hemoglobin concentration of less than 30 per cent, or a saturation index below 0.90. Then ormocytic or macrocytic varieties are less common than the hypochromic and are suggested strongly by a mean corpuscular hemoglobin concentration of 30 per cent or greater, and a saturation index of 1.0 or higher. Such anemias are pernicious anemia, those due to nutritional disturbances, sprue, some cases of pregnancy, nephritis, aplastic anemia, the leukemias and lymphoblastomas.

It should be emphasized that with the methods employed, only those blood dyscrasias associated with an anemia will be detected. In some hematological conditions, which in their early stages are concerned primarily with changes in the white blood cells, or blood platelets, the blood survey would give no indication of their presence. These are, after all, comparatively rare, and their presence is usually suggested by conspicuous changes on the physical examination such as splenomegaly, lymphadenopathy, or purpura. In their later phases, moreover, there is often an associated anemia, which would attract attention to the condition in the routine blood examination. It is not feasible, nor would it be profitable, to attempt a total white blood cell count, or a determination of the differential white blood cell formula in the routine examination of a large number of patients. This would be done only for the sake of recognizing a very few cases in which there is no associated anemia, at least in the early steps of the condition. The methods which are used in a routine blood survey must be only those which are practically applicable, as judged by the use of the same procedure in a large number of specimens simultaneously.

Incidence of Anemia. Of the 736 patients examined, approximately 24 per cent had an anemia as indicated by a hemoglobin of less than 84 per cent (13.2 gm.) in the case of the males, and below 78 per cent (12.0 gm.) in the females. It was somewhat surprising to find, as indicated by the following figures, that there was no great difference in incidence in the two sexes, as it has been commonly thought that the condition was more prevalent in girls and women. Our figures showed, however, that 23.6 per cent of the males, and 25.5 per cent of the women had an anemia. It should be kept in mind, however, that children are excluded from this survey, and furthermore, more extended observations may alter these figures. The severity of the anemia is indicated by the following figures: slight (below 84 per cent for males, 78 per cent for females), 24.6 per cent; moderate (below 78 per cent for males, and 70 per cent for females), 8.3 per cent; moderately severe (below 71 per cent for males, and 64 per cent for females), 3.5 per cent; severe (below 66 per cent for males, and 58 per cent for females), 1.5 per cent. If the percentage of incidence for a two weeks' study could be applied to an entire year of operation of the hospital, the incidence of anemia could be expressed as follows, in actual number of cases: those with slight anemia 4,235 cases, moderate 1,427, moderately severe 608, and severe 257. As routine blood examinations are done ordinarily only in the medical division of the out-patient department, it is obvious that many cases of anemia, especially those with

the milder degrees of the condition, would go undetected.

Benefits of a Routine Blood Examination. The advantages of a routine blood examination at once became apparent to the members of the medical staff of the University Hospital as soon as the results of the two weeks' survey period became available. Moreover, the enthusiasm for the procedure which then developed has become even greater in the first few months of its operation on the basis of a complete year's trial.

It is now possible to say definitely in the case of all patients admitted to any department of the University Hospital, either as an in-patient or out-patient, whether or not an anemia exists. As almost 1 patient in 4 has a demonstrable anemia, it is obvious that some reliable and simple routine measure of detecting such a condition is justifiable. There can be no question that many mild degrees of anemia are persistently overlooked, even by experienced hematologists. Moreover, in some instances, moderately advanced or severe grades of the condition may not be detected, especially by those who do not have a special interest in blood diseases. It is well known that certain varieties of anemia may present the symptoms of cardiac, renal, nervous or even endocrine disorders, and the underlying cause of the complaints will not be detected, unless a hemoglobin determination is made. For these reasons, it appears as logical to do such a routine examination as the performance of the usual urinary tests.

With the modern clinical method of routinely estimating the hemoglobin of all patients, although it requires apparatus which is more expensive than that which have been used in the past, it is possible to have a standardized technique applied to each patient throughout all of the services of the hospital. Furthermore, this remains as permanent information for all time and serves a useful purpose in comparing the level of the hemoglobin of patients on multiple admissions.

These investigations may also be utilized to make useful observations during the present world conflict, as the results obtained from month to month may be some indication of the adequacy of the dietary intake of persons in this area. While the food curtailments now made necessary have no hint of an important limitation of calories, or even the essential materials in food, it is possible that for unforeseen reasons, these may cause an increase in the frequency of anemias. If blood disorders did occur from dietary restrictions, they would probably be of the iron deficiency type or those nutritional varieties due to lack of an adequate amount of protein intake. These could probably be controlled easily by relatively simple measures such as the addition of more protein or a few cents worth of iron daily to the diet.

In conclusion, let me urge that nothing be subtracted from the diagnostic study of the patient which is now done, such as the complete history and physical and roentgen examinations, and the usual laboratory tests. Whenever possible, however, I would urge the routine use of microfluorograms of the chest and a blood examination. The latter should include at least a hemoglobin measurement by the most accurate modern method, and a hematocrit reading which serves as a basis for calculating the mean corpuscular hemoglobin concentration, and the saturation index. These indices would give useful information concerning the nature of the anemia when present.

SEDIMENTATION RATE OF THE ERYTHROCYTES

The information derived from a determination of the sedimentation rate, by the method which can most conveniently be applied, is undoubtedly of value especially as an indication and index of infection in the body. Its limits of reliability and usefulfulness under the conditions employed still remain to be determined, but the answers to these questions should be available after the completion of a year's trial.

The sedimentation rate in this blood sur-

vey was determined in the Wintrobe hematocrit tube, and the extent of the fall at the end of one hour, measured in millimeters, was adjusted in both males and females to a hematocrit value of 47 per cent. This correction partially compensates for the effect of an anemia on the sedimentation rate, and makes it possible to classify both men and women by the same scale of values.

Nature and Significance of the Sedimentation Rate. The rate per hour at which red corpuscles settle in plasma which have been prevented from clotting by the addition of oxalate is called the sedimentation rate. It was introduced by Fahraeus[3] of Sweden who noted the phenomenon when searching for a test of pregnancy. The rate does become increased in pregnancy but it is no longer used as a test for that condition as it was found that other body states also could influence it. It is now employed as a valuable diagnostic aid because it is an exceedingly sensitive, nonspecific reaction which is a measure of the presence and intensity of certain morbid processes in the body. These, in general, can be grouped under the following three headings: (1) acute and chronic infectious processes; (2) tissue destruction; and (3) malignancy. It has been demonstrated repeatedly that it is normal in health. There is a gross increase in acute and chronic infectious diseases, generalized and local infections, and tissue destruction, such as occurs following trauma. There is a moderate increase in pregnancy, mild infections, or trauma, leukemia and lymphoma, malignant neoplasms, some types of liver disease with jaundice, acute and chronic nephritis, chronic congestive heart disease, coronary thrombosis, and thrombosis in general.

Undoubtedly one of the most important uses of the sedimentation test is that it furnishes evidence of disease processes of which there is no indication derived from the routine history and physical examination. For example, at the Henry Phipps Institute, in Philadelphia, a careful study[4] was made of a group of 177 patients in whom the general routine examination revealed no abnormalities but in whom the sedimentation rate was accelerated. Additional study led to the discovery of the following conditions in the 177 patients who had an increased sedimentation rate:

Basal non-tuberculous infiltration of the lungs	96
Latent apical tuberculosis	32
Positive Wassermann reaction	35
Pelvic inflammatory disease	5
? Carcinoma of the lung	1
	169

In only 8 of the 177 patients was there no abnormality found on the more intensive re-examination.

It has been emphasized by Wintrobe,[4] however, that a normal sedimentation rate does not necessarily signify the absence of disease. He found, for example, that in 444 cases with a normal sedimentation rate, 8 had the following organic conditions: 1 patient with fever of undetermined origin, 2 with chronic nephritis and pronounced renal insufficiency, 1 with active pulmonary tuberculosis, 1 with cirrhosis of the liver, 1 with carcinoma of the colon, and 2 with pyelitis.

It should be emphasized, therefore, that the sedimentation rate is an exceedingly valuable diagnostic measure which indicates that the patient has a condition which should be investigated with great care, but it is nonspecific, and hence does not assist in determining the particular disease from which the patient is suffering. Furthermore, like many other laboratory procedures, errors may be introduced in its determination by minor variations in the technical details of performing the test. There can be no doubt, however, that with the proper technique, it gives information which cannot be obtained in any other way, and that is of importance in diagnosis from both a positive and negative standpoint. A careful study is now in progress, during this year at the University Hospital, in an attempt to evaluate the test. In an effort to do this, all patients in whom the test is positive are carefully investigated, as well as those in whom there is a discrepancy be-

tween this laboratory finding and the condition of the patient. Our present attitude is to regard an increased sedimentation rate, if technically correct, as indicative of either a disease or state of pregnancy, until a searching examination excludes these two possibilities. In a very general way we have also adopted, along with others interested in the test, the following tentative attitude in interpreting an increased sedimentation rate: it suggests that

1. The patient has an organic, rather than a functional disease.
2. The condition is most likely inflammatory rather than a tumor.
3. If a tumor, it is malignant instead of a benign growth.
4. Furthermore, it is helpful in the differential diagnosis between coronary thrombosis and angina pectoris, rheumatoid arthritis and osteoarthritis; and pelvic inflammatory disease from an uncomplicated ovarian cyst.

While our present discussion concerns the use of this procedure as a diagnostic measure, it should also be mentioned that it is an exceedingly valuable index of the activity of certain disease processes. For example, it is now generally recognized that variations in the sedimentation rate reflect the intensity of the certain morbid processes more accurately than the pulse rate, body temperature, changes in body weight, or physical signs. It is even claimed by some that an increase in the rate may forecast a spread of pulmonary tuberculosis before evidence of this appears in the roentgenogram. Furthermore, a normal rate, if technically accurate, and in the absence of advanced cachexia, is convincing evidence against active tuberculosis in the body. I shall mention briefly only one other condition in which the test serves as an excellent index of activity of the disease process, and that is in patients with rheumatic fever. It is now recognized that an elevated rate persists in this disease, even after the body temperature, pulse rate, and leukocyte count have been normal for some time. It is therefore the most sensitive index of activity in patients with disease, and a valuable aid as an indication of the duration of bed rest.

Changes in the Sedimentation Rate Observed in the Two Weeks' Survey. In our series of 593 patients in whom this test was performed, elevated values were found in 48.4 per cent. If one excludes the instances of slight increases, the incidence was 33.1 per cent. In interpreting the test, readings between 0–10 millimeters per hour were considered normal, 11–15 mm. slightly increased, 16–25 mm. moderately increased, and 26 mm. or over markedly increased.

With the exclusion of the slight changes, approximately one-third of all patients admitted had an increase in rate which required careful investigation from a diagnostic standpoint. Furthermore, it is of value as a routine test in some instances in determining the state of a pathologic lesion. For instance, in interpreting the importance of an apical pulmonary lesion, it would be of value in indicating the presence or absence of activity.

At present, as far as this study is concerned, only three points will be emphasized, namely:

(1) The sedimentation rate when employed routinely is found to be significantly increased in at least one-third of all patients registering at the University Hospital.

(2) It may be of great diagnostic significance both as positive and negative evidence.

(3) Additional observations are necessary to evaluate the test, under the conditions in which it is used, but all indications are that it will be a great diagnostic aid.

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ACUTE PNEUMONITIS*

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DURING the past few years a disease entity variously called acute pneumonitis, virus pneumonia, acute interstitial pneumonitis, atypical pneumonia or atypical bronchopneumonia of unknown etiology has received increasing attention in diverse localities. Like most investigators we prefer the term "acute pneumonitis" as being the most descriptive. This term was first used and defined by Allen[2] to designate an acute form of respiratory infection characterized by a benign course, few physical signs, and roentgenological evidence of a localized inflammatory process in the lung.

The diagnosis of acute pneumonitis has become more common in the past two years, largely because of the more intensive use of chest roentgenography. It was the results of this procedure that stimulated our interest in this disease when we found that at least one out of every seven patients with the diagnosis of acute catarrhal fever† admitted to the medical wards at the U. S. Naval Air Station in San Diego showed a definite area of pulmonary consolidation on roentgenograms of the chest. During the period of this study, 534 patients were admitted with the tentative diagnosis of "acute catarrhal fever." Of these 534 patients only 145 had roentgenograms made of the chest. Of the 145 who had chest roentgenograms there were 74 who had areas of pulmonary consolidation of the type we refer to as acute pneumonitis and who should not be classified as cases of acute catarrhal fever. Neither were they the true influenzal pneumonias as these patients did not exhibit the prostration nor complain of the bone and muscle aches which accompany influenza. The leukopenia in influenza also aids in the differential diagnosis, because in acute pneumonitis there is a normal or slight increase in the leukocytes. While patients with acute pneumonitis have areas of pulmonary consolidation many of them are without physical signs. They do not in any way present a picture of pneumonia as it is commonly understood. These patients may even be ambulatory and are much less toxic than pneumonia patients. The term pneumonia should be restricted, as it is a very serious disease which demands different treatment and generally has a more serious prognosis.

† Acute catarrhal fever is a diagnostic term advocated by Bernard Fantus and is used as an all-inclusive term to include the many different types of benign acute upper respiratory infections. It is the most common diagnosis made in the U. S. Navy. During 1940 the Navy reported 27,312 cases of acute catarrhal fever, for a total loss of 140,698 sick days.

Since the acceptance of this article for publication, the Medical Department of the U. S. Navy officially lists the cases of acute pneumonitis as "Pneumonia atypical, etiology unknown." It was also recognized as a contagious disease and was made reportable.

CLINICAL ASPECTS

A review of the literature indicates that this disease may run the gamut from the mildest type of case—even asymptomatic and afebrile—to that of the utmost severity, eventuating in death. The vast majority, however, run a benign, though sometimes protracted course. Very few deaths have been reported. Fredd,[8] in studying a series of 23,463 chest roentgenograms taken in the Lower Harlem Health Center, New York City, in a period between 1936 and 1938, for the purpose of determining the prevalence of pulmonary tuberculosis, discovered 64 cases of asymptomatic pneumonitis. He reports other ambulant, afebrile patients with coryza and mild cough as the sole symptoms, showing similar

* The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

roentgenologic densities, which resolved in several weeks. He is convinced of the importance of chest roentgenograms in the so-called upper respiratory infections and that many cases of lung involvement now unrecognized would be disclosed by roentgen examination.

The cases reported by Allen in 1936 were, for the most part, intermediate in severity. He found 68 cases of acute pneumonitis among 2,081 cases of respiratory disease at the Service Station Hospital, Fort Sam Houston. These cases were characterized by the usual symptoms of upper respiratory infections, such as coryza, cough, fever, malaise; notably absent were the initial chill, the rusty sputum, and the sharp chest pain typical of lobar pneumonia. Defervescence was commonly rapid, though in some a low grade, irregular fever persisted for many days. Physical signs in the chest were either entirely absent or rather obscure. When present, they usually consisted of fine or medium moist râles or coarse râles appearing late, and rarely impaired resonance or bronchovesicular breathing. In Allen's series the febrile course lasted three to eight days with an average of five to six days. None of his cases were fatal.

Smiley[23] and his co-workers reported a series of similar cases. They followed 86 such patients in Cornell University Infirmary over a fifteen month period. They stress the features of scanty sputum and few complications and point out that coarse râles may persist for two weeks after discharge from the hospital. They believe that their cases are also identical with the "acute influenza pneumonitis" described by Bowen, that occurred in Hawaii from 1931 to 1934. Moreover, reports on similar cases have come from other colleges,[9,10,15,17,19] and hospital centers.[16,20] In many of these cases a second rise of temperature occurs after the initial week of illness and the fever may persist for fifteen to eighteen days.

Severe infections have constituted a small percentage of the above cases, but those reported by Reimann[21] and Scadding[22] were particularly serious. After several days of mild symptoms of hoarseness and sore throat, the temperature rose to high levels, 104°–105° F., persisted for some time, and then declined by lysis; the total febrile period lasted from eighteen to twenty-five days. Temporary remissions of temperature in some cases suggested the biphasic character seen in many virus diseases. Patients suffer greatly from a harassing, exhausting cough, which is usually dry or only slightly productive. Dyspnea and cyanosis are frequent in this group of cases.

ROENTGENOGRAPHIC ASPECTS

In patients with symptoms of an acute respiratory infection the demonstration of a localized area of pulmonary consolidation by chest roentgenography is the cardinal point in the diagnosis of acute pneumonitis. It is difficult to determine how soon the pulmonary changes become apparent on the roentgenogram, but Murray[17] in his study of this disease at Harvard University demonstrated their occurrence within the first twenty-four hours. Smiley and his co-workers[23] state that definite roentgen evidence often did not appear for thirty-six to forty-eight hours after the onset of clinical symptoms. However, in the great majority of cases the roentgen findings are present several days before abnormal physical signs can be detected.

There is nothing characteristic about the appearance of the area of pneumonitis that is pathognomonic of this disease. However, it is easily identified when seen in epidemic form among young robust military personnel. Murray[17] describes the appearance well by saying it is usually an area of hazy density extending out from the hilar region into the lower lung field and occasionally into the mid lung field (Fig. 1 and 2). In the beginning the margins are poorly defined and gradually fade away into normal lung. The area of infiltration rarely reaches the periphery of the chest. As the disease progresses, the area of pneumonitis becomes more dense and larger,

with the margins more sharply defined. The shape of the consolidation is usually that of a fan or of a rounded area. The distribution is definitely lobular rather than lobar. With resolution the density gradually diminishes and the infiltration becomes mottled, patchy and more linear in type (Fig. 3). Resolution, according to Murray,[17] Rainey and Burbidge[19] and in our experience may be completed in one week to ten days. It is not unusual for the patient's symptoms to disappear before complete resolution has occurred on the roentgenogram. Likewise, the area of pneumonitis, as it appears on the roentgenogram, seems to be large and out of proportion to the relatively mild symptoms and malaise that afflict the patient.

All reports agree that the lower and middle lobes are involved by far the most frequently. Consolidation immediately about the hilum occurs next in frequency, and the upper lobes are involved the least. In patients with mild symptoms it is common to find a small area of consolidation limited to the lung in a costophrenic angle (Fig. 4). In our series of 74 cases, 52 occurred in the lower and middle lobes, 9 immediately about the hilum, 5 in the upper lobes, and 8 had bilateral involvement.

LABORATORY FINDINGS

All the writers referred to concur that the leukocyte count is generally normal or slightly increased and shows an essentially normal differential picture. Occasionally an absolute leukopenia is encountered. There is a tendency for the leukocyte count to increase as the disease progresses. Sputum studies rarely reveal any organism beyond those normally found in the mouth or nasopharynx.

The etiology remains undetermined,[3] but most investigators strongly suspect a virus, especially when the disease has occurred epidemically, evincing, as it does, its highest communicability. The incubation period has been variously estimated as being from seven to twenty days. Reimann[21] ascribes the failure to isolate a virus in most cases to its weak pathogenicity for the particular species of animal inoculated, although his co-workers isolated an unusual virus from the nasopharyngeal washings of one of his patients and from the blood of another, after excluding the presence of the virus of influenza.

Very significant is the report of Hornibrook and his collaborators[6,12] on an epidemic of 15 cases of puneumonitis in which an identical causative agent, the *Rickettsia* of "Q" fever, was isolated in 3 out of 4 cases in which a search was conducted.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis is not easy, according to most observers, particularly when the disease does not occur in epidemic form. Isolated cases of pneumonitis due to bacterial infection, primarily or secondarily, may occur from bronchial obstruction or around localized areas of bronchiectasis.[4,18] These require appropriate methods, such as bronchoscopy and lipiodol injection, to establish the diagnosis. Influenza, tuberculosis, undulant fever, tularemia, psittacosis, fungus infections, certain lymphomas and even periarteritis nodosa must be considered[3,4] in the differential diagnosis of isolated cases.

PATHOLOGICAL FINDINGS

In the relatively few fatal cases, the chief autopsy findings in the lungs have been hemorrhages and edema.[1] On section the lungs show areas of deep red, moist solidification which, on microscopic examination, reveal thickening of the interalveolar septa, hemorrhagic exudate with a predominance of mononuclear cells and no fibrin in the alveoli and bronchial tree. The alveolar epithelium is edematous. Adams[1] made a study of an epidemic of pneumonitis involving 32 infants with 9 deaths and found characteristic cytoplasmic inclusion bodies in the bronchial epithelial cells, whereas Goodpasture and his co-workers[11] discovered nuclear inclusions in the epithelial cells of the trachea, bronchi, and alveoli of infants dying of a severe "virus pneumonia."

TREATMENT

All investigators who used chemotherapy found that it was without benefit, as would be expected in virus infections, although some mentioned its hypothetical use to subdue secondary bacterial invaders. Reimann[20] is emphatic in his attitude:

> Obviously, every patient with fever and a few rales in the lung should not be subjected to the discomforts and hazards of chemotherapy. . . . It is just as important to know when not to use chemotherapy and when to stop it as it is to know when to use it. . . . It would be important to know how many patients who supposedly die from an infection actually die from drug poisoning. . . . There is at present no basis for their [sulfonamide drugs] use as prophylactics.

Lederer and Rosenblat[13] deplore the indiscriminate and uncontrolled use of sulfathiazole and cite 4 cases in which death was attributable to this drug.

Those experienced with treating this disease stress the importance of keeping the patient in bed for an adequate length of time, in some instances even a week after subsidence of fever in order to obviate a prolonged course and the rather frequent relapses. The importance of intelligent and adequate treatment can be emphasized by reviewing the salient hazards of this disease:

(1) Acute pneumonitis is highly communicable.

(2) A definite area of pulmonary consolidation involves the lung or lungs. It varies in size, but is nearly always larger than a silver dollar and is a potential source of serious trouble.

(3) There is a tendency to relapses, though there are few complications.

The treatment should therefore be directed primarily to handling these factors; isolation, if feasible; bed rest until patient is fever free, for at least three days; combat fever and general discomfort with appropriate symptomatic medication and nursing care; force fluids; keep bowels open, etc. One must remember that acute pneumonitis is a potentially serious disease, but only prompt care and protection is likely to keep it benign.

REPORT OF CASES

During a four month period 74 cases of acute pneumonitis have come under our observation at the Naval Air Station Dispensary, North Island, San Diego, California. The following represent some of the more illustrative and more carefully studied cases taken from this group:

Case I. E.M.S.. a sailor, aged thirty-two, was admitted to the ward on May 1, 1942, complaining of a cough with production of rusty sputum of one week's duration. During the twenty-four hours prior to admission he had chills and fever and slight aching pain in the right chest while coughing. Examination revealed an acutely ill, somewhat obese white male with a moderately injected pharynx and signs of a small area of consolidation with bubbling râles in the right lower lobe posteriorly. Temperature, 101.4° F.; pulse, 86; respiration 20. White blood count: 8,900 with 12 per cent band forms, 48 per cent segmented forms, 31 per cent lymphocytes, 4 per cent eosinophiles, 1 per cent basophiles, 4 per cent monocytes. Culture of the sputum showed only the usual nasopharyngeal flora. A roentgenogram of the lungs revealed a small area of pneumonitis, about 3 cm. in diameter, in the right lower lung field. The patient was put on sulfathiazole. Prompt defervescence ensued during the first two days and the patient improved clinically. Nevertheless, a roentgenogram of the chest on the fifth day showed the area of pneumonitis to be increased. Since the patient continued to remain asymptomatic and had recovered clinically, he was discharged on the tenth day.

Comment. The salient features of the disease are all present in this history, namely, moderately severe upper respiratory symptoms, general malaise, slight to moderate fever and leukocytosis, roentgen evidence of a small area of pulmonary consolidation, and the relatively prolonged period of resolution after the disappearance of the acute symptoms.

Case II. (Fig. 1.) B.E.C., yeoman, aged twenty-one, was admitted to the Dispensary April 3, 1942, complaining of headaches, fever,

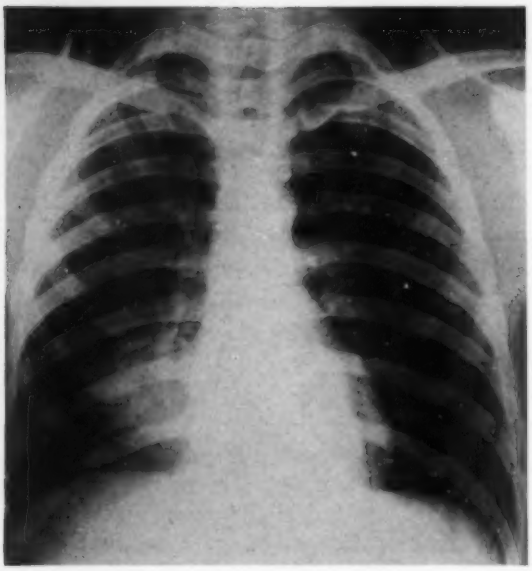

Fig. 1. Case II. The large area of pulmonary consolidation in the lower and medial portion of the right lung is typical of the more severe cases of acute pneumonitis. The area of consolidation spreads out from the lower border of the right hilum to cover a fan-shaped area. The consolidation is homogeneous with the borders fading away into normal lung.

and general aching of six days' duration. He showed the usual signs of a common cold. Temperature was 101° F.; pulse and respirations were normal. On the third day the patient felt worse, had nausea and vomiting and appeared unable to tolerate sulfathiazole (given prophylactically). On the fourth day a roentgenogram of the chest showed a large area of pneumonitis in the right lower lobe. The patient was transferred to U. S. Naval Hospital, San Diego. Examination there revealed some injection of the pharynx and suggestively dull areas in the right posterior chest, and moist râles in both lower lobes posteriorly. On the fifth day a roentgenogram of the chest showed an increase in the area of pulmonary infiltration. The patient gradually improved with only symptomatic treatment and was discharged as well on April 25, 1942.

Comment. This case serves to illustrate that most of the patients with acute pneumonitis have prodromal symptoms of an acute upper respiratory infection for forty-eight to seventy-two hours before developing an area of pulmonary consolidation which is usually first detected from a roentgenographic examination of the chest. Another feature demonstrated by this case is that many of these patients run only a low fever even though there is a large area of pulmonary consolidation present.

Case III. J.R.S., a young sailor, was admitted to the sick bay May 1, 1942, with a history of cough productive of a moderate amount of brownish sputum, and malaise, increasing in severity for five days. Physical examination revealed an acutely ill white male with a temperature of 100.6° F., pulse 88, respiration 20, and with the only other positive findings in the right lung, in the right lower lobe of which were showers of medium, moist râles and slight dullness. A roentgenogram of the lungs showed a slight hazy, diffuse area of pneumonitis in the lower and medial portion of the left lung. Culture of the sputum showed the usual nasopharyngeal flora. White blood count: 6,100 with 6 per cent band forms, 62 per cent segmented forms, 28 per cent lymphocytes, 2 per cent eosinophiles and 2 per cent monocytes. By the sixth day the patient had been asymptomatic and afebrile two days and a check-up chest roentgenogram showed resolution of the pneumonitis. The patient was accordingly discharged to duty as recovered.

Comment. This case is typical of most of these in which blood counts and sputum cultures were done; the results were within normal limits. Some cases show slight to moderate leukocytosis; a rare case, leukopenia.

Case IV. (Fig. 2.) J.A.P., a Marine, aged twenty-one, was admitted to the ward March 30, 1942, with the complaint of chills and fever aggravated by inspiration and a dry cough of twenty-four hours' duration. Physical examination revealed an acutely ill young white male with a temperature of 102.6° F.; pulse, 140; respiration, 24. There were suggestive signs of early left lower lobe consolidation. A chest roentgenogram on the second day revealed an area of pneumonitis about 7 cm. in diameter in the left lower lobe. The patient was placed on sulfathiazole therapy and transferred to U. S. Naval Hospital, San Diego, California, where chest roentgenograms taken on April 2 and 7 showed, respectively, a localized area of pneu-

monitis close to the hilum on the right, and clearing of the increased density described on the right. At the hospital the patient had a "severe sulfathiazole reaction, amounting to considerable shock." He was discharged to duty three weeks after he was first seen.

Comment. The use of sulfathiazole in this patient was more of a hazard than a benefit. The drug was not tolerated by the patient described in Case II. In Case V and in others the area of pulmonary infiltration actually increased in size during the administration of the sulfathiazole. In our experience the "sulfa" drugs should not be used routinely in the treatment of acute pneumonitis.

Case V. R.B., a Marine, aged twenty-two, was admitted to the ward April 11, 1942, with a history of symptoms of an acute upper respiratory infection, including fever, eye pain and non-productive cough of four days' duration. Examination revealed an acutely ill young white male with positive findings of an acute conjunctivitis and pharyngitis and tender, palpable posterior cervical lobes. The chest was clear. Temperature, 103.4° F.; pulse, 100; respiration, 20. Examination was not otherwise remarkable. The first roentgenogram of the chest revealed a diffuse, patchy area of pneumonitis involving the lower and medial portions of both lungs. The patient was given sulfathiazole therapy, and his temperature gradually subsided. On the fourth day another chest roentgenogram disclosed that the areas of pneumonitis in the lower fourth of each lung were larger. However, the patient improved from then on and became afebrile by the seventh day. At that time musical râles could still be heard in the left lower lung posteriorly, and a chest roentgenogram showed that resolution was taking place. By the tenth day the chest was clear except for a few rhonchi in the left lower lobe. On the twelfth day the patient was discharged as recovered.

Comment. This case is presented because this was one of the few who had bilateral areas of pneumonitis, but chiefly because even during three days of sulfathiazole therapy the areas of pneumonitis grew larger.

Case VI. (Fig. 3.) H.H.D., eighteen year old

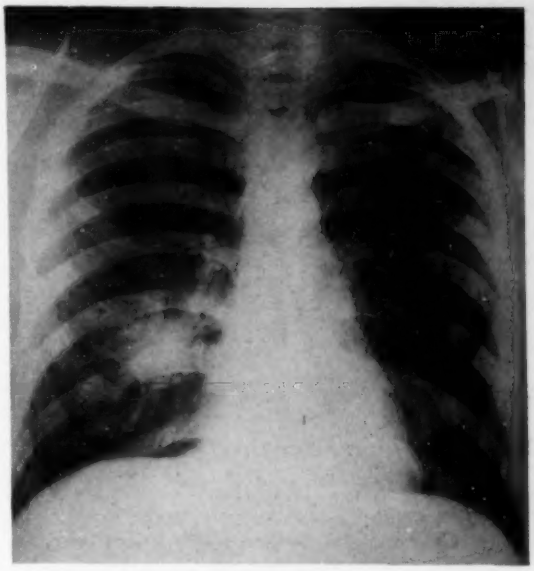

Fig. 2. Case IV. In less severe cases the area of pneumonitis is smaller, more rounded, and is usually isolated by normal lung. The rounded contour is the result of the lobular distribution that is characteristic of acute pneumonitis. Here, also, the edges gradually fade away into normal lung.

private, came to the Dispensary on April 14, 1942. His chief complaint was a persistent cough of a week's duration which had become productive in the past two days. He had a fever of 100° F. He gave a history of having had a deep chest cold for about ten days. He was a student in the Aviation Machinists' School and did not want to miss the final two weeks of the course. Consequently, he had continued to attend school and carry on his routine duties. At the time he presented himself for examination râles could be heard in the lower portions of both lungs. He felt under par but not very ill, and refused to enter the hospital because he wanted to take his final examinations in the subsequent two days. Since he agreed to return for examination each day this request was granted and no untoward results occurred.

Comment. This case is a good example of the fact that most of these patients are not as sick as one would expect them to be from the size and appearance of the lung involvement, as shown on the chest roentgenograms. It is probably patients of this type who gave rise to the descriptive term "walking pneumonias."

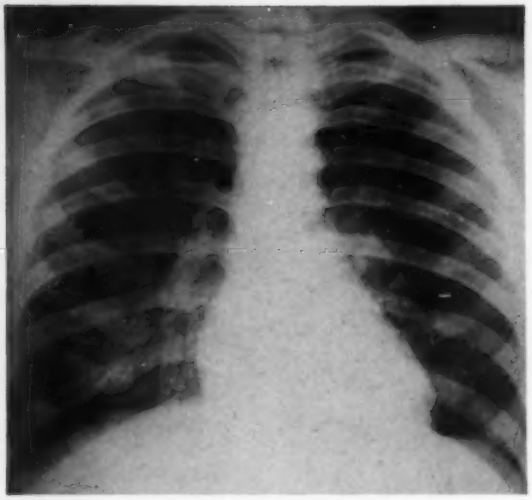

Fig. 3. Case vi. This roentgenogram is a good example of the diffuse, patchy, flocculent change which takes place during resolution. The largest area of pneumonitis was in the lower and medial portion of the right lung and a smaller area involved the same portion of the left lung. This eighteen year old private first reported to sick call on the day this roentgenogram was made. For over a week he had been "dragging himself about" apparently with fever and for the last two days with a productive cough. With as large an area of lung involved as shown on this roentgenogram one would think that the man would have been too sick to attend the classes at the Aviation Machinists' School. This discrepancy between the amount of the lung involved and the severity of the symptoms is one of the features of this disease.

Case vii. (Fig. 4.) S.S., a young seaman, had a slight chill accompanied by feverishness and headache before arising on the morning of April 10, 1942. He was immediately admitted to the ward and found to have only a pharyngitis and occasional coarse rhonchi in both lungs, a temperature of 102.2° F., pulse 118, and respirations 20. Even in the absence of positive physical signs of pulmonary consolidation a large area of pneumonitis was demonstrated on the chest roentgenogram involving the lower and outer portion of the right lung. Sulfathiazole therapy was instituted. For the next two days his temperature hovered around 103°–104° F., pulse 110–115 and respirations 20–22, followed by sharp subsidence of these signs to normal on the fourth day. Another chest roentgenogram at that time showed that the area of pneumonitis had become patchy and was undergoing resolution. On the fifth day the temperature rose to 100.0° F., but thereafter the patient remained afebrile and improved steadily. Roentgenograms made on the eighth and tenth days showed further clearing, but complete resolution did not take place until the thirteenth day. The patient was then discharged as recovered.

Comment. This case demonstrates two characteristic features of acute pneumonitis. First, that fairly large areas of pulmonary consolidation can be demonstrated on the chest roentgenogram before the physical signs of consolidation are apparent. Second, that chest roentgenograms reveal that considerable pulmonary infiltration is still present in the lungs after the temperature has become normal and acute symptoms subsided.

Discussion

It will readily be seen from these illustrations that our cases fall into the groups of mild and moderately severe infections, that they are strikingly similar clinically, roentgenographically, and also from a laboratory standpoint to the vast majority of pneumonitis cases of corresponding sever-

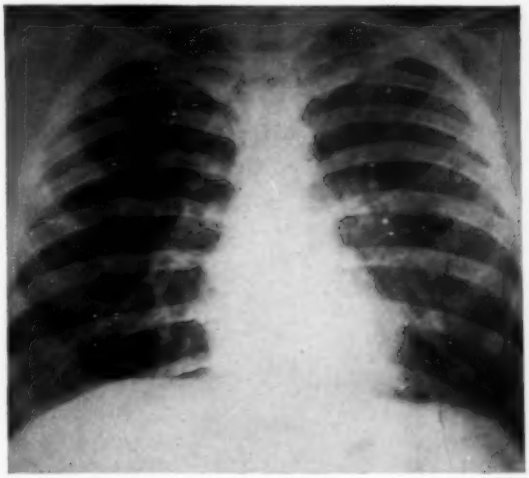

Fig. 4. Case vii. In the mild cases of acute pneumonitis a small and less dense area of pulmonary consolidation is frequently found in the portion of the lung that fills the costophrenic angle. This case is typical and the symptoms usually disappear before there has been complete roentgenographic resolution.

ity which occurred in epidemic form and which were reported in the literature. We agree with most authorities that roentgen examination of the chest is essential to making the diagnosis, although in some cases the diagnosis was suspected even though the physical signs were meager. Although we had no facilities to search for an etiologic agent beyond the reasonably certain exclusion of pathogenic bacteria in some instances, the clinical and epidemiological evidence would seem to point to a virus infection, just as it did in most of the epidemics cited above. Furthermore, we are in whole-hearted agreement with Reimann and others that expectant and symptomatic treatment, as well as adequate bed rest, are to be preferred to chemotherapy in these milder cases. This conclusion was arrived at in retrospect, for many of our patients actually did receive sulfathiazole, but without apparent benefit. However, in the more severe cases, with moderate to large areas of pneumonitis, the trial use of chemotherapy is rational, especially when the virus origin of the disease is in doubt.

Here one must also bear in mind that recent experimental evidence has shown a 9 per cent reduction in the ability to withstand anoxia in animals, following the ingestion of sulfonamide drugs. It is therefore reasonable to assume that the flying ceiling of aviation personnel receiving such a drug might well be lowered for even some time after recovery from an infection. Moreover, impaired judgment following such chemotherapy has been found to be frequent.[7] The possible results of these changes are obvious.

The purpose of this paper is not so much to report another series of cases of acute pneumonitis as it is to emphasize the importance, frequency, and communicability of this disease. We feel that these features are not thoroughly appreciated, not only by civilian doctors as a whole, but naval medical officers as well. To realize this, one need only refer to those very common and ubiquitous diagnoses of "grippe," "upper respiratory infection," and, in the Navy, "acute catarrhal fever." It is evident that these terms are often "catch-baskets" for diseases of similar clinical pictures but of multiple etiology. We are convinced that epidemic acute pneumonitis is frequently misdiagnosed. For example, most of our cases were at first thought to be acute catarrhal fever. During the above-mentioned four month period, 534 cases of catarrhal fever were admitted to the Dispensary as compared with 74 cases of acute pneumonitis. It is obvious, therefore, that about 1 out of 7 cases of "catarrhal fever," on the basis of these statistics, might be expected to have pulmonary involvement. This does not even take into consideration the reasonable assumption that many more cases of pneumonitis would have been brought to light by routine chest roentgenograms in our cases of "acute catarrhal fever."

In emphasizing the incidence of this disease, it should be pointed out that cases of acute pneumonitis have occurred with almost equal frequency during the winter, spring and summer months at this station.

It is a reasonable presumption that with the crowded and intimate living conditions occasioned by military life there will be a marked increase in the prevalence of acute pneumonitis in the ensuing year, with a consequent greater appreciation of this disease.

SUMMARY

1. A review of the literature reveals that acute pneumonitis occurring in epidemic form is far from uncommon and is quite contagious. It is recommended, therefore, that acute pneumonitis be considered communicable and therefore a reportable disease.

2. Clinically and roentgenographically, and in certain laboratory aspects, these cases bear a distinct resemblance to the milder and moderately severe cases of acute pneumonitis reported in literature.

3. The prevalent opinion is that such infections are probably of virus origin and are therefore not responsive to chemotherapy.

This should be borne in mind when prescribing for aviation personnel, for in the light of recent experimental evidence, it is quite possible that such drugs will lower the flying ceiling of an individual, as well as produce impairment of judgment.

4. It is reasonable to assume that many of these cases are erroneously diagnosed as "grippe," "upper respiratory infection" and "acute catarrhal fever," which often present similar symptoms.

5. The more frequent use of chest roentgenograms will doubtless disclose an even higher incidence of this disease. Roentgenographic examination of the chest is the most important procedure in establishing the diagnosis.

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Vol. 50, No. 4

CHRONIC COR PULMONALE*

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ENLARGEMENT of the right heart, with or without right heart failure, and independent of any abnormality in the left heart, occurs more commonly than has been generally supposed. Aside from congenital defects within the heart itself and the rare defects of the tricuspid valve, such lesions are usually the result of chronic disease of the pulmonary tissues or of the pulmonary vessels. Strictly speaking, the term "cor pulmonale" should be confined to this group of cases, although Brill[1] has widened its applications so that it covers practically all types of heart disease. For the purposes of this discussion "cor pulmonale" may thus be defined as enlargement of the right side of the heart, with or without failure, initiated by increased resistance to blood flow within the lesser (pulmonary) circulation as a result of pulmonary disease.

With the inception of an increased resistance to blood flow a state of hypertension in the pulmonary circulation develops. The effect of this is to throw a strain on the right side of the heart with the result that the right ventricle is compelled to contract against an increasing load comparable to the increased work imposed on the left ventricle as a result of arterial hypertension. Dilatation of the pulmonary artery and its branches and dilatation and hypertrophy of the conus pulmonalis and right ventricle characterize the pathological process, and when failure of the right side of the heart eventually supervenes, the clinical picture is manifest by signs of increased venous pressure; namely, distention of the neck veins, hepatic enlargement, ascites, and edema.

The mechanism whereby increased resistance to blood flow is brought about in the pulmonary circuit is thought to be as follows: There may be an obliteration of the capillary bed such as occurs in pulmonary emphysema or pneumoconiosis; or the disease narrows the pulmonary circulation such as may occur in pulmonary arteriolar sclerosis. Because the vascular reserve of the pulmonary circulation is said to be great, it is apparent that considerable destruction of pulmonary parenchyma must occur before a sufficient amount of capillary bed is obliterated to increase pulmonary pressure. This concept is in agreement with clinical and pathological observations, which show that considerable pulmonary involvement must be present before signs of right-sided enlargement can be demonstrated.

Although in the past chronic pulmonary heart disease has been looked upon as a rare condition, more recent studies have served to change this opinion. Griggs, Coggin and Evans[3] recently reviewed the autopsy protocols of all cases of chronic pulmonary disease encountered in the Los Angeles County General Hospital. They employed the average thickness of the wall of the right ventricle as a criterion of hypertrophy. A right ventricular wall which averaged 5 mm. or more in thickness was considered definitely hypertrophied. They concluded that chronic pulmonary disease was an important cause of cor pulmonale. Silicosis showed the highest percentage incidence of cor pulmonale. Right ventricular hypertrophy occurred in 52 per cent and congestive failure in 50 per cent of 24 patients. Right ventricular hypertrophy occurred in 28.9 per cent and congestive failure in 22 per cent of 45 cases of emphysema. The hearts of patients with pulmonary tuberculosis showed right ventricular hypertrophy in but 3.7 per cent and definite congestive failure in 1.8 per cent of 1,470 cases. The latter figures differ greatly from

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those reported by Nemet and Rosenblatt,[6] who found exclusive hypertrophy of the right ventricle in 34 per cent of 71 cases of tuberculosis.

Kountz, Alexander and Prinzmetal[5] separated and weighed the right and left ventricles of the hearts of 17 patients with marked emphysema and found dilatation of the right ventricle in 10 out of 17 cases with hypertrophy of both right and left ventricles in most of the cases.

Scott and Garvin[10] have recently reviewed a series of 6,548 autopsies to determine the incidence of primary right heart enlargement, excluding congenital defects, regardless of the presence or absence of right heart failure. It should be noted that they also used the thickness of the right ventricle as a criterion of right heart enlargement. In this series there were 790 patients who had died of heart disease, of which 50, or 6.3 per cent, appeared to represent examples of cor pulmonale.

Clawson,[2] in a review of 30,265 autopsies in the records of the Department of Pathology of the University of Minnesota, found 4,678 cases in which death resulted from heart failure. Sixty-nine, or 1.5 per cent, of the total could be definitely considered cases of pure right heart enlargement resulting from lesions of the lungs or of the lesser circulation. The smaller number in this series as compared to that of Scott and Garvin's is no doubt due to the use of heart failure rather than enlargement as a criterion. The leading cause of right heart enlargement in this series was pulmonary tuberculosis, representing 16 cases. This high incidence is probably the result of Higgins'[4] careful scrutiny of the right heart in the autopsies of patients dying at the Glen Lake Sanatorium for tuberculosis. The second most common cause was bronchial asthma, representing 15 cases. Bronchiectasis was the cause of the right heart enlargement in 9 cases, primary pulmonary arteriosclerosis in 9, nonspecific emphysema in 3, and silicosis in two. The remaining cases were of varying origin.

The attention of roentgenologists is directed to this condition because it is probably given insufficient emphasis in the ordinary course of examination. Right heart enlargement will be found frequently in patients with chronic pulmonary disease or long-standing bronchial asthma. Higgins[4] reports that approximately 30 per cent of all the tuberculous patients coming to autopsy at the Glen Lake Sanatorium show evidences of right heart failure. In a series of 41 cases of bronchial asthma coming to autopsy, Truog and Rigler[12] found 25 per cent to have died of right heart failure. Thus the incidence of right heart enlargement or failure is not rare as a complication or cause of death in individuals with chronic pulmonary disease.

Clinical studies relating the incidence of chronic cor pulmonale to chronic pulmonary disease are meager. This is because of the particular difficulty encountered in recognizing right-sided cardiac strain by clinical examination. When signs of gross congestive failure are found, then the diagnosis becomes readily apparent. But in a large majority of cases clinical signs indicating failure of the right side of the heart have not yet developed to the point where edema, ascites, or hepatic enlargement are evident. In this group of cases clinical recognition of enlargement of the right side of the heart becomes a difficult and very important diagnostic problem. In the first place, symptoms of cardiac disease are strikingly similar to symptoms which arise from chronic pulmonary disease; namely, cough, dyspnea, and orthopnea. Second, evidence indicating strain of the right side of the heart cannot be elicited with accuracy by physical examination. Percussion of the cardiac borders to determine the presence of right-sided enlargement is too unreliable because in a great majority of instances pulmonary emphysema is present. Accentuation of the pulmonic second sound is often a very helpful sign, but too much reliance cannot be placed on it alone because pulmonary heart disease may be encountered in young individuals; furthermore, cor pulmonale in the elderly individual is occasionally associated with strain and enlargement of the left side of the

heart, conditions which may give rise to accentuation of the pulmonic second sound. If it were possible to estimate the level of the blood pressure in the pulmonary circulation with the same ease as in estimating the systemic blood pressure, then the recognition of right-sided cardiac strain would become a simple matter.

From this it is apparent that the recognition of chronic cor pulmonale presents many diagnostic difficulties. Without further objective evidence the best the clinician can hope to do is to speculate on the possibility of the presence of right ventricular strain unless signs of right heart failure are present. To obtain definite objective evidence, recourse must be had to more refined clinical methods such as are afforded by electrocardiography and roentgen examination, of which the latter is far more valuable. By careful roentgen examination cardiac involvement in cases of chronic pulmonary disease can be recognized in a large percentage of cases by evidence of enlargement of the right side of the heart. Using this method, Parkinson and Hoyle[7] have demonstrated the occurrence of right-sided cardiac enlargement in approximately 50 per cent of their series of 80 patients who were suffering from a high degree of emphysema. In a series of 52 cases of bronchial asthma with emphysema, Rigler and Troug[8] found some roentgen evidence of right-sided enlargement in 46 per cent of cases.

The work of Robb and Steinberg[9] and more recently of Sussman, Steinberg and Grishman[11] using contrast cardiography is most significant. By studying the position of the interventricular system the latter authors demonstrated some degree of enlargement of the right ventricle or of the base of the pulmonary artery in 24 of 28 unselected cases of emphysema of various types. In some respects their studies are even more significant than those reported at autopsy because minor enlargement of the right ventricle is difficult to determine postmortem.

Because the total size of the heart is often not remarkably increased, this condition may readily be overlooked even on roentgen examination. Furthermore, especially when pulmonary tuberculosis or conglomerate silicosis is the etiological factor, the extensive pulmonary changes commonly present are likely to dominate the roentgen findings, causing the right heart enlargement to be overlooked. Yet the latter is a very serious prognostic omen and is frequently the direct cause of the patient's death in cases of chronic pulmonary disease.

One of the causes of chronic cor pulmonale, which is less common but extremely important, is pulmonary arteriosclerosis, often called pulmonary hypertension. In this instance the lesion originates in the pulmonary vessels themselves rather than in the parenchyma of the lung, as is the case in tuberculosis, emphysema, silicosis, and other fibrotic conditions. The roentgen appearance of the lungs, therefore, is strikingly different. The enlargement of the right ventricle and pulmonary trunk is marked as in all cases of cor pulmonale, but in addition the branches of the pulmonary artery are enormously enlarged and show an unusual degree of pulsation. In such cases in addition to the usual methods of roentgen examination, roentgen kymography is of some value. It will reveal a marked increase in the amplitude of pulsation of the main pulmonary trunks; it would appear from kymographic study that the increased pulsation in the peripheral pulmonary vessels is due entirely to transmission rather than to actual expansion of the vessels themselves.

Roentgenologic studies, especially by means of roentgenoscopy, must be made in all four standard positions; namely, posteroanterior (Fig. 1, 3, 6 and 8), right lateral (Fig. 2), right anterior oblique (Fig. 4), and left anterior oblique (Fig. 7). The visualization of the esophagus filled with barium (Fig. 2) is of some value, but largely in a negative way.

The characteristic feature of the roentgen findings is due to enlargement of the right ventricle and of the pulmonary trunk. This dilatation of the outflow tract of the right

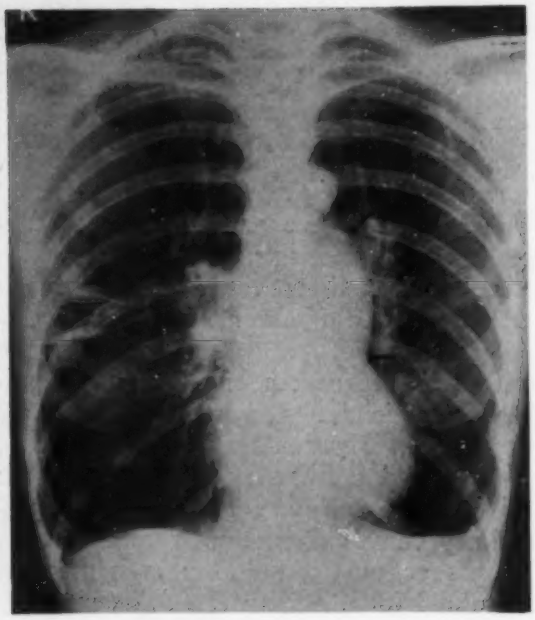

Fig. 1. Right heart enlargement in a case of chronic nonspecific emphysema of extreme grade. Note the extremely low diaphragms, wide interspaces and diffuse changes in the lungs characteristic of emphysema. The pulmonary trunk is greatly enlarged (arrows), and the pulmonary arteries, especially at the right, show marked enlargement. While there is a high-grade right heart enlargement, the heart as a whole is not markedly increased in size.

ventricle differs from the characteristic enlargement of the pulmonary conus seen in mitral disease. In the latter the enlargement is essentially due to a congestion of the pulmonary veins incident to failure of the left atrium. Hence there occurs an overwork of the right ventricle in an effort to force blood through the lungs into the left heart. In the case of a true cor pulmonale there is increased resistance to the flow of blood by the pulmonary arteries, either as a result of pressure from ephysematous or fibrotic lungs, or from pulmonary artery hypertension—a matter which is difficult to prove—or from actual sclerotic narrowing of the pulmonary arteries and arterioles. While here, too, there is hypertrophy and dilatation of the right ventricle with consequent enlargement of the conus arteriosus, there is in addition marked dilatation of the pulmonary artery which overshadows, to a considerable extent, the enlargement of the conus itself. In addition, the absence of enlargement of the left atrium produces a distinct difference in the shape of the heart even in the posteroanterior projection. It is important to realize these differences because they help to explain the means of differentiation of lesions confined to the right heart from those incident to disease of the mitral valve.

In the posteroanterior view (Fig. 1, 3, 6 and 8) a characteristic enlargement of the pulmonary trunk, the second curve on the left side of the heart is shown. This is accompanied by some enlargement of the pulmonary conus curve, the third curve on the left side, but the latter is a much less prominent factor. In addition, the major branches of the pulmonary artery may also

Fig. 2. Right lateral view in the same case as Figure 1. Note evidences of emphysema. There is a distinct anterior enlargement of the pulmonary conus (arrow). Pulmonary arteries are shown also greatly enlarged (arrows), lying just anterior to the esophagus. Note the absence of esophageal displacement, indicating no enlargement of the left atrium. The enlargement is thus seen to be confined to the right side of the heart.

be dilated well beyond the normal. Examination in the right oblique position (Fig. 4) brings out the enlargement of the pulmonary trunk, which extends anteriorly and becomes very prominent. In the left oblique position (Fig. 7) the absence of any prominent enlargement of the left ventricle is clearly made out. Examination with barium-filled esophagus (Fig. 2) will reveal the absence of any enlargement of the left atrium, a striking feature of pure right heart disease. If the right pulmonary artery is unusually large it may show some indentation on the anterior wall of the esophagus, although this is not at all common. It may also extend its shadow upward to obscure the aortic window (Fig. 4). As has been stated before, roentgen kymography will record markedly increased pulsations of the pulmonary trunk and its major branches; such findings are usually visible roentgenoscopically as well.

In the examination of the posteroanterior roentgenogram the evidences of chronic pulmonary disease may be apparent (Fig. 1, 3 and 5), the findings obviously depending upon the nature of the chronic process.

Fig. 3. Posteroanterior view in a case of chronic bronchiectasis and pulmonary fibrosis. Moderate right heart enlargement is shown especially by the marked enlargement of the pulmonary trunk and to some degree of the pulmonary conus (arrow).

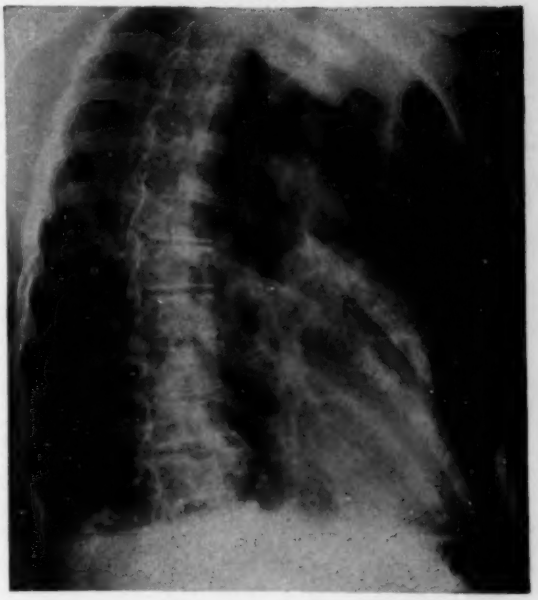

Fig. 4. Right oblique view in the same case as Figure 3 showing marked enlargement of pulmonary trunk and also of conus pulmonalis (arrow). Note the upward extension of the pulmonary arteries (arrows).

The roentgen findings of chronic tuberculosis are usually quite apparent. The same is true of conglomerate or extensive silicosis (Fig. 5) or of bronchiectasis and lung fibrosis (Fig. 3). In both of these there is usually present a high degree of emphysema as well. In the case of bronchial asthma and emphysema (Fig. 1) the findings may be much less obvious, but careful examination of the posteroanterior and lateral views will give the usual roentgen evidences of emphysema, which have been well described.

In the case of primary pulmonary arteriosclerosis (Fig. 6 and 8) these findings in the parenchyma of the lungs will be absent. In their place will be found a much more striking increase in the size of the pulmonary trunk and its major branches together with a marked increase in the size of the pulmonary vessels extending well out to the periphery. In some instances these peripheral vessels appear to pulsate actively, although careful studies with the roentgen kymogram would indicate that this pulsation is simply an increased degree of motion transmitted by the greater ampli-

Fig. 5. Abnormally shaped heart in case of silicosis with lung fibrosis with death from right heart failure. Owing to the extensive changes in the lungs, characteristic heart changes are not clearly apparent, but the enlargement of the pulmonary trunk (arrow) is seen and some beginning dilatation of the right atrium.

tude of pulsation in the pulmonary trunk.

It should be noted that there is a distinct absence of pulmonary congestion in the true sense of the word in these cases of right heart failure. The pulmonary vessels may be enlarged, but it is the pulmonary arteries which are visible and they maintain their distinctness. There is, of course, an increase in the amount of blood passing through the lungs, but there is no tendency toward transudation of serum into the alveoli. Obviously if the lung fields are thoroughly involved in some pathologic process, it is difficult to make such fine distinctions, but in the case of pulmonary arteriosclerosis this difference can be made out in the appearance of the lung fields (Fig. 8). The sharply outlined appearance of the enlarged pulmonary arteries differs radically from that occurring in pulmonary congestion and edema such as attend ordinary left heart failure. Similar pulmonary findings may be present in cases of patent ductus arteriosus.

The clinical findings of right heart failure need not be reviewed here in great detail. They are familiar to all clinicians and consist essentially of orthopnea, anasarca, edema, enlargement of the liver, distention of the neck veins, and frequently cyanosis. One of the striking and important signs of right heart failure is the elevation of the venous pressure, which can be used effectively in determining the presence of this condition.

Normal rhythm is an outstanding feature. It was observed in all our patients regardless of the presence or absence of heart failure. The blood pressure is usually normal. Accentuation of the pulmonic second sound, indicating increased pulmonary pressure, is observed. In none of our cases was a diastolic murmur elicited. In 3 cases apical systolic murmurs were heard. Percussion of the cardiac borders to determine the presence of enlargement of the right side of the heart is of little value and in most of the cases is misleading. Only in one case was enlargement of the region of the pulmonary artery elicited by percussion. Obviously in the presence of pulmonary emphysema percussion is a very unreliable method to determine the size of the heart.

Fig. 6. Posteroanterior view in a case of pulmonary arteriosclerosis. The heart is greatly enlarged with particularly marked dilatation of the pulmonary trunk and of the pulmonary arteries.

The electrocardiograph was found to be of considerable assistance in determining the presence of predominant right ventricular strains. Right axis deviation was found in 9 cases. Normal axis deviation was found in 5 cases and left axis deviation in one case. A striking feature of the electrocardiographic records was the presence of high and pointed P waves in the second and third leads. This was noted in 10 cases. In the patient who had left axis deviation these characteristic P waves were found. Low potential was noted in two records, and depression of ST interval in the fourth lead was observed in about 15 per cent of the cases.

The differential diagnosis from a roentgenologic standpoint is not always simple. In the ordinary type of acquired cardiac disease producing right heart enlargement, namely, mitral stenosis and regurgitation, differentiation is not difficult. Here the pulmonary trunk is usually enlarged to a much lesser degree while the third curve on the left side, the pulmonary conus, to which is added no doubt the shadow of the left auricular appendage, is much more prominent. In addition, definite displacement of the esophagus by the enlarged left atrium is usually present; this can be determined in the right oblique or right lateral positions. Pulmonary congestion rather than real dilatation of the pulmonary arteries is likely to be present, and the result is a more hazy, ill-defined mottling throughout both lungs as compared with the sharply defined shadows of the pulmonary arteries which are present in right heart enlargement.

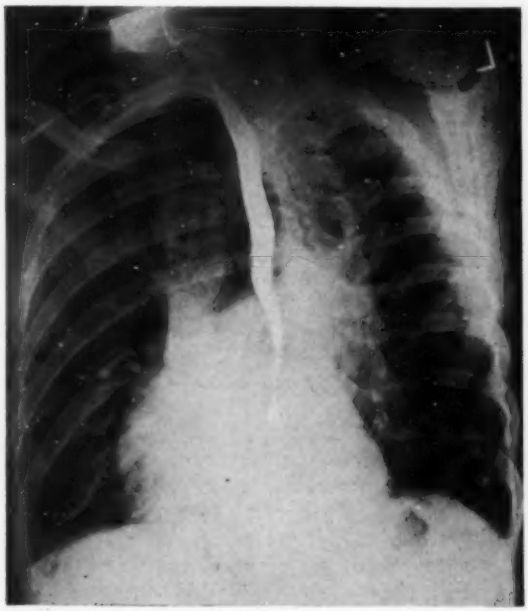

Fig. 7. Left oblique view in the same case showing the enlargement of the right ventricle anteriorly and to the right (arrows).

Fig. 8. Pulmonary hypertension or arteriosclerosis with marked enlargement of the heart. Note the characteristic enlargement of the pulmonary trunk (arrow). There is a moderate enlargement of the right ventricle. The pulmonary arteries are greatly enlarged, particularly well shown on the right side (arrows), but even extending well out to the periphery. The specific difference between the dilatation of the pulmonary arteries and the picture of chronic congestion seen in mitral disease should be noted. The differentiation of this condition from patent ductus arteriosus is difficult but can be accomplished if the physical findings are taken into consideration.

In most congenital defects the differentiation is also not extremely difficult, particularly if the physical findings are borne in mind. In the vast majority of instances of patent ductus arteriosus and other char-

acteristic defects of this type, murmurs are of such a nature as to make the diagnosis quite apparent when combined with the roentgen findings; the roentgen examination alone, however, may somewhat simulate the picture of right heart failure from pulmonary arteriosclerosis. In the case of defects of the interatrial septum the differential diagnosis may occasionally be extremely difficult. Here, too, there is marked enlargement of the right ventricle, of the truncus pulmonalis, and of the pulmonary vessels, and often relatively few physical signs to help in the differentiation. The history of an extremely long-standing process dating to early childhood may be of value, and the presence of a systolic murmur often heard over the pulmonic area may be somewhat helpful. In general, the heart size will be larger and the dilatation of the pulmonary arteries more extreme in the congenital defects than in ordinary right heart failure from chronic pulmonary disease. But the distinction between congenital defects and primary disease of the pulmonary vessels is largely dependent upon the history and physical signs.

The heart in hyperthyroidism may tend to simulate right heart enlargement. There tends to occur some enlargement of the pulmonary trunk and in some instances of the right ventricle. Usually the degree of enlargement is far less, and there are usually signs of generalized cardiac enlargement as well. Heart failure is very uncommon, and the other signs of hyperthyroidism are in evidence.

Chronic cor pulmonale is characterized by its progressive but chronic course extending over a period of years. Most of the patients die of intercurrent infection, especially pneumonia. Others, particularly in the older age group, die of associated cardiac disease such as hypertension or coronary disease. However, a certain number of patients, as indicated above, die of isolated right heart failure. In a small number of cases death may occur suddenly and unexpectedly from pulmonary embolism.

CONCLUSIONS

In our experience right heart enlargement and failure have been a common finding. It is an important cause of death in chronic tuberculosis, in bronchial asthma and other emphysemas, in silicosis, and is the usual cause of death in pulmonary arteriosclerosis. Every case of chronic lung disease should be examined with this in mind. By roentgenoscopic and roentgenographic study in all positions the characteristic enlargement of the pulmonary artery and the right ventricle may be demonstrated. The roentgen findings are by far the most important means of establishing the presence of right heart enlargement before failure has supervened and are most helpful in the differential diagnosis.

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THE TECHNIQUE FOR LOCATING AND IDENTIFYING PERICARDIAL AND INTRACARDIAC CALCIFICATIONS*

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NUMEROUS questions as to the exact technique of locating and identifying areas of calcification in the heart and pericardium have led to this summary of our work. Most of this material has already been published,[1,2,10,11,12,19] but very little of the technique has been incorporated in textbooks of radiology and cardiology.[3,5,6,7,16] The proper technique, although easy to acquire, has not been practiced in most places, and has led, therefore, to disappointments. Most of these have to do with the demonstration of calcified areas on the roentgenogram. To clarify this situation is the object of this presentation, summing up the technical procedures, adding a few details which have improved our accuracy since the original reports, and evaluating the importance of these findings.

No roentgenologist should be content to examine a patient for heart disease by films alone. Roentgenoscopy is the much more important part of the examination, and the more one does, of course, the greater facility and skill he acquires. Roentgenograms rarely add anything if the roentgenoscopy is carefully and thoroughly done, but they do furnish a permanent record and a check on the roentgenoscopic findings. They may, however, add important details in the lungs, ribs, spine or other structures outside the heart. The roentgen kymogram has been very little help in our routine clinical work. Oblique roentgenograms of the heart, both right and left, are of more value than lateral views and should be a part of every record.

A. Method.

1. Calcified areas within the heart shadow are most easily found by roentgenoscopy but sometimes they are difficult to record on films.

2. The only equipment necessary is a standard fluoroscope and good fluoroscopic vision. A fine focus roentgen tube and a fine grain fluoroscopic screen, such as the Type B, give best results, using a 5 inch gap (65 kv.) and 5 ma. current.

3. The observer's eyes should be prepared by at least fifteen minutes' rest in a completely darkened room, or by accommodation during gastrointestinal examinations. Part of the accommodation is dilatation of the pupil; the more important part, the accumulation of visual purple in the retinal rods. Inasmuch as the macula lutea (fovea) has no rods and no rhodopsin or visual purple, it is possible to pick up the dancing calcified areas in one's peripheral vision, and sometimes when the calcified areas are small or faint, they may be seen better by concentrating the central vision just to one side of the suspected area. This holds true of all roentgenoscopic work when attempting to see fine details or small lesions. If the observer concentrates too much and too long, retinal fatigue will ensue, making it necessary to rest the eyes for a few moments. It is wise to have a standard test for dark adaptation to decide when the observer's vision is sufficiently good to proceed with such an examination. In my work I have used a radiolite wrist watch, now twenty-five years old, and rather dim. When the individual figures on the watch dial are perceptible sufficient adaptation is present. It is well known that this occurs more rapidly on cloudy or dark days and more slowly on bright, sunny days or when the observer has been facing bright lights. The range of variation is usually from ten to twenty minutes.

4. The observer must look *through* the heart shadow, searching for dark dancing shadows which move to and fro with sys-

* From the Department of Roentgenology, Peter Bent Brigham Hospital, Boston. Presented at the Forty-Second Annual Meeting American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.

tole and diastole. The patient (facing the roentgenoscopist) should be rotated slightly to his left to throw the heart shadow away from the spine. Search for calcified areas is facilitated by deep inspiration held during observation. This increases contrast and also helps differentiate extracardiac calcifications by their lack of movement. A small roentgenoscopic aperture cuts down secondary radiation, increases contrast, and facilitates the finding of intracardiac calcifications.

position in the roentgenographic room by means of the skin marks, the tube is brought up close to the patient, with a cone 10 or 15 cm. in diameter centered on the posterior mark, and the fastest possible exposure made on a small cassette with fast screens. The tube film distance is 24 to 30 inches. The patient, of course, again takes a deep breath and holds it. This not only increases the contrast by expanding the lungs, but also slows the heart rate by vagal stimulation, thereby improving the chances

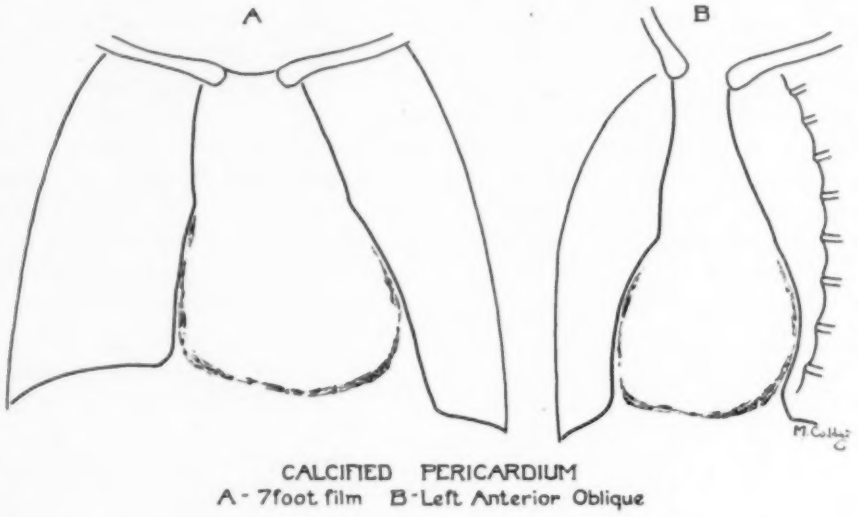

Fig. 1. Calcification in the pericardium. Diagram to show the subepicardial location of extensive pericardial calcium deposits. These deposits may be more or less extensive, may be present in only one area, or may form a ring around the heart in the auriculoventricular groove.

5. When to look for calcification in the heart:

a. All cases suspected of heart disease.
b. All known cases of heart disease.
c. All patients with enlarged hearts.
d. All patients over sixty years of age.

6. Where to look: Using a small roentgenoscopic aperture the heart can be "scanned" in a few seconds. The *place* to search for each type of calcification is detailed below under the various types of calcification.

7. Having found intracardiac shadows, roentgenograms can be made most accurately by marking the spots on the skin anteriorly and posteriorly in the position where they show best. Duplicating this of an exposure without movement. Using 200 ma. and the kilovoltage indicated by the thickness of the patient's chest, 1/20 second usually gives a good result. Using 500 ma. and raising the voltage 4 to 6 kv., especially if the heart is enlarged, 1/60 second will give even better results.

There are many confusing shadows in such roentgenograms, particularly in elderly persons, but with a little experience one can readily refer the shadows seen roentgenoscopically to the correct one on the roentgenograms, ruling out calcified costal cartilages, Ghon tubercles, calcified lymph nodes, and other extracardiac shadows. We do *not* depend upon our roentgenograms for the diagnosis, but

simply for confirmation and record of what has been found by roentgenoscopy.

B. Types of Calicifications.

1. *Pericardial Calcifications.* These are the result of inflammatory processes, frequently tuberculous pericarditis, and are visible roentgenoscopically as flat segments or irregular plaques just inside the heart shadow (Fig. 1). By rotating the patient through 180 degrees, some point will be found where the calcified areas will be close to the periphery of the heart shadow, indicating their superficial location. These shadows are best seen on edge. They move with the heart shadow on respiration and rotation, but may show only a little or no excursion with systole and diastole. This finding always indicates an *adhesive* pericarditis, but not necessarily a *constrictive* pericarditis. A calcified ring in the pericardium in the auriculoventricular sulcus entirely encircling the heart has been found several times with no antecedent history of disease and no signs or symptoms whatsoever. Clinically important pericardial calcifications are most commonly found over the ventricles themselves, less frequently over the auricles, occasionally surrounding and interfering with one of the venae cavae. A very common location is on the diaphragmatic surface of the pericardium. It is important to search for pericardial calcification in patients with unexplained ascites, or those with peripheral signs of heart failure without pulmonary signs or symptoms, i.e., right heart failure.[2]

2. *Valvular Calcifications.* The mitral and aortic valves most frequently undergo calcification. We have found only one case of tricuspid valve calcification and none, so far, in the pulmonic valve.* We estimate that 10 per cent of the patients with rheumatic mitral stenosis will show calcification in the mitral valve roentgenoscopically, whereas 90 per cent of patients with aortic stenosis will have enough calcium in their aortic valves to be visible roentgenoscopically. These calcified valves are most easily found in a slight right anterior ob-

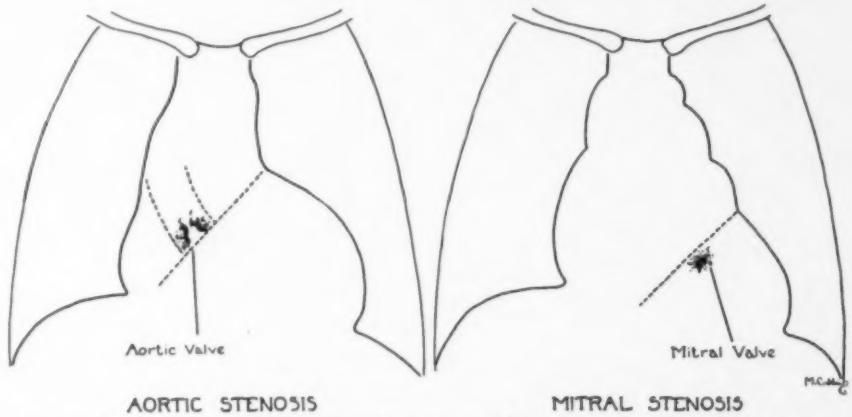

Fig. 2. Calcification in aortic valve (left) and mitral valve (right). Diagram to show the marked difference in position which may be found in posteroanterior projection. The relation to the auriculoventricular junction on the left border, however, is practically the same in both instances.

* We reported one case of calcification in the pulmonic valve in a twenty-six year old girl[2] but the calcification in the pulmonic valve was not recognized *in vivo*. This was an unusual case and the heart was unusual as at autopsy we found marked calcification in the mitral, the tricuspid and the pulmonic valves, while the aortic valve was entirely normal. There was also a large defect in the interventricular septum, which may have been the deciding factor in determining this unusual distribution of the valvular calcification. Conceivably there may have been a considerable shunt of blood from left ventricle to right ventricle, causing an increased strain on the pulmonic valve while decreasing the strain on the aortic valve. We know that damage, sometimes followed by calcification, may occur at points of abnormal strain. We have just recently seen a patient with demonstrable calcification, presumably in the wall of the right ventricle opposite a ventricular septal defect. This has not been confirmed by autopsy, but cases have been reported where such calcification in the endocardium of the right ventricle opposite a septal defect was found at autopsy.

In the case noted above, however, the calcification of the pulmonic valve may have been on a congenital pulmonic stenosis. The patient was known to have both congenital and rheumatic heart disease before death.

lique position, with the patient holding a deep breath. Locate the auriculoventricular junction on the left border of the heart, then search *through* the heart on a line 45° from the horizontal from this point downward and medially toward the right cardiophrenic angle. Both valves will be found on or near this line and they can be quickly

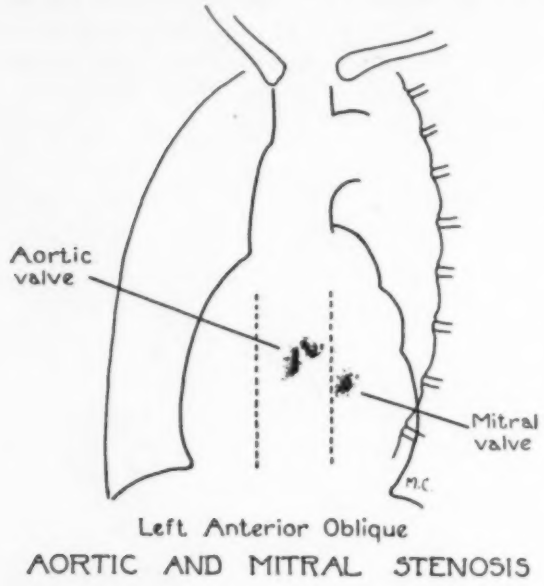

Fig. 3. Calcification of both aortic and mitral valves. Diagram to show their relative position in the left anterior oblique view. These relative positions are also true when only one valve is calcified, but the shape of the heart may be considerably changed.

recognized as irregular, dark, dancing shadows. As a rule, the calcified mitral valve will be found nearer the apex of the heart than the aortic valve which is nearer the base (Fig. 2). This is due to the fact that in mitral disease the greater bulk of the heart shadow is made up of the dilated auricles, while in aortic stenosis the hypertrophied ventricle forms the greater part of the heart shadow. A fairly accurate guess can be made as to which valve is calcified by its relation to the rest of the heart shadow, and by the size and shape of the heart. The slight right anterior oblique position is the best one for *finding* the calcified valves, but the best position for *differentiating* between mitral and aortic valves is the left anterior oblique, where the apex of the heart just clears the spine on deep inspiration. In this position the mitral valve is found in the posterior third of the heart shadow and the aortic valve in the middle third (divided longitudinally, parallel to the spine) (Fig. 3).

The movements of these calcified valves with systole and diastole are frequently striking and vary considerably. They may move in a linear course, either perpendicularly, obliquely or even horizontally. Some of them cover an elliptical or oval course, some circular, a few even move through a jerky triangular orbit. Their amplitude of motion frequently exceeds the excursion of the heart border, suggesting that the valve and auriculoventricular "septum" play the part of a piston in the pumping action of the heart. No constant difference in the motion of aortic and mitral valve has been recognized, but when both valves are calcified, a slight but appreciable difference may be seen, with a split-second interval between the two movements and sometimes a rocking or see-saw movement between the two valves.

The actual timing of the valve movements and the amplitude of their excursion may be recorded by roentgen kymography[8,17,18] or by moving pictures of the roentgenoscopic image, using the technique and special apparatus described by Stewart and his associates.[14,15]

3. *Calcification of Mitral Annulus Fibrosus.* Calcification of the mitral ring (annulus fibrosus) is frequent in elderly persons and often forms in large dense masses easy to see roentgenoscopically and easy to identify. The mass is apt to be large, of homogeneous density and either J-shaped, U-shaped, or ↄ-shaped (Fig. 4), whereas the calcified valve is apt to be irregular, nodular and more like a calcified mesenteric node in appearance. Although the aortic valve also has a supporting ring or annulus fibrosus, so far we have found visible calcification only in the mitral annulus. The annulus fibrosus may move as much as the calcified valve and in much the same manner. It is very interesting to

listen over the apex of the heart with a stethoscope while watching the calcified valve or annulus. It will be noted that the valve and annulus both move toward the apex of the heart during systole and away from the apex in diastole.

4. *Coronary Arteries.* Calcification in the coronary arteries can be recognized roentgenoscopically using the same technique described above. The most common location of visible calcification is in the circumflex branch of the left coronary artery, just beneath the pericardium and just below the auriculoventricular notch on the left cardiac border. The calcified areas here are seen as a faint linear shadow, segmented, with a smooth curve convex upward. Spot roentgenograms will show parallel segments of calcium deposits easily identifiable as being in the walls of the artery (Fig. 5). Less frequently, calcification can be recognized in the anterior descending branch of the right coronary artery. Its position close to the surface of the heart can be determined by following the shadows roentgenoscopically while rotating the patient to right and left. A third and quite easily visible spot of calcification can be found in the auriculoventricular sulcus posteriorly with the patient in the left anterior oblique position. This is also in the circumflex branch of the left coronary artery and, being end-on in this view, shows as a small dense circle (Fig. 5). The calcified coronary arteries also move with the heart beat but much less in amplitude than the valves or annulus. Their excursion is synchronous with and the same in amplitude as the adjacent heart border.

5. *Myocardial calcifications* are more rare, but massive areas of calcification may occur in old infarcts or old thrombi. These are most frequently found at or near the apex of the heart in the wall of the left ventricle. Extensive calcification of infarcted areas has also been found in the interventricular septum. One of our cases occurred in an eighty year old physician with a history of cardiac infarct twenty years before. The faint diffuse calcification of the myocardium sometimes found in association with a parathyroid adenoma cannot be visualized under the roentgenoscope. These areas vary in their amplitude of movement, depending, of course, upon the contraction of the myocardium in which they are located. In occasional cases there is little if any excursion with systole

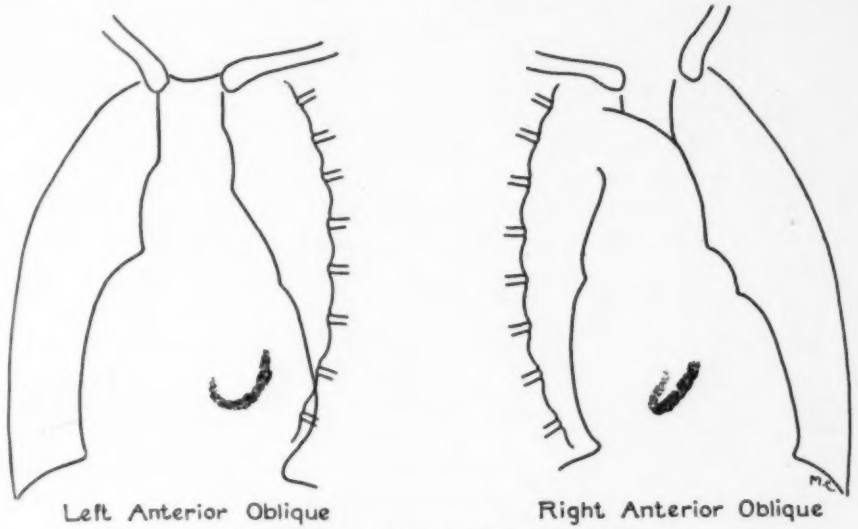

Fig. 4. Calcification of mitral annulus fibrosus. Diagram to show the usual appearance and position of this calcification in the two oblique views. It may lie even closer to the posterior wall and apex of the heart than indicated in the left anterior oblique view.

and diastole suggesting firm adhesions and fixation. In apical infarcts it may be difficult to differentiate between calcification in the myocardium and that in the pericardium. Not infrequently both are present. We have not seen paradoxical pulsation in any of these calcified infarcts, although aneurysms of the ventricle are prone to calcify.

6. *Endocardial calcification* (except in the mitral and aortic valves) is also rare and usually so thin that it is often difficult to determine whether the calcified deposits are in the endocardium of the auricle or in the pericardium over it.

7. *Calcification in tumors of the heart* is the rarest of this group and, alone in this series, has not yet been recognized during life. All of the other types have been found and identified roentgenoscopically during life and confirmed at postmortem examination. We have one case of benign cardiac

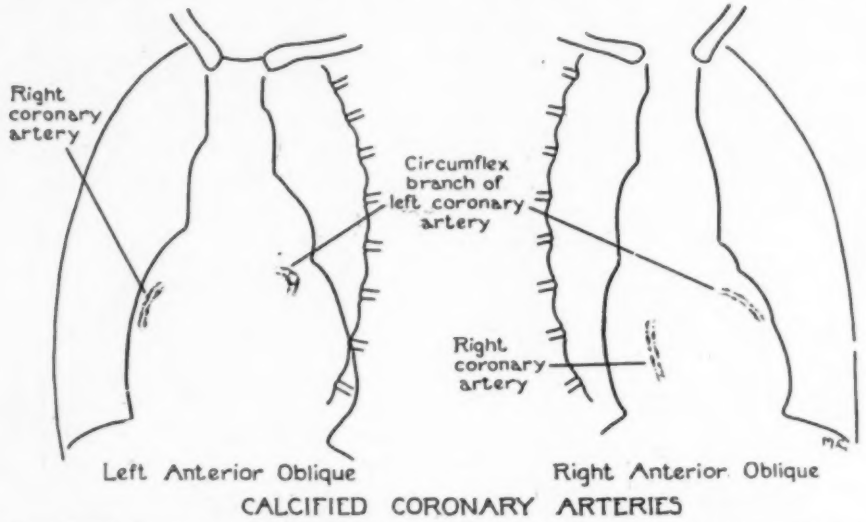

Fig. 5. Calcification of coronary arteries. Diagrams to show the location and positions where calcified deposits in the coronary arteries are most commonly seen during roentgenoscopy. Rarely both coronary arteries may be visualized throughout most of their course.

apt to be small in amount. This is most frequently found in the walls of the auricles and its clinical and pathological significance is frequently uncertain. It may be found opposite a septal defect where the abnormal current strikes the endocardium. We have seen one case (unconfirmed) where the calcification was presumably in the lateral wall of the right ventricle opposite a defect in the interventricular septum.

Their movements with systole and diastole are slight but recognized as the excursion of the auricles is usually one-half of that of the left ventricle. In general, the best way to locate these calcified areas is to watch them roentgenoscopically while rotating the patient from side to side, up to 180 degrees. The walls of the auricles are

tumor containing a large mass of calcification found incidentally at postmortem in a child. The mass of calcification was large enough to have been easily visible roentgenoscopically had it been attempted.

C. Clinical Importance of Findings.

As in so many other conditions, the clinical value and importance of these findings is apt to vary inversely with the clinical acumen of the referring physician or cardiologist.

1. In pericardial calcifications, for example, the clinical picture of constrictive pericarditis may be clear cut and unequivocal, in which case the roentgenoscopic findings are merely confirmatory, yet they warn the surgeon that he has not only adhesive but also calcific pericarditis facing

him. On the other hand, these findings may decide or explain a condition or symptoms which are otherwise indefinite or inconclusive. Not infrequently the roentgen findings are the first clue to the patient's condition, but just as frequently they may be purely incidental and of no clinical importance, as not all cases of adhesive pericarditis, even if calcified, cause symptoms. Furthermore, only a portion of the cases of constrictive pericarditis will also have calcified areas, but that is another problem which does not concern us here. When calcified areas are present in the pericardium they can usually be visualized roentgenoscopically; they should be sought for under certain conditions, and when found, offer very definite and concrete evidence of a preexisting pericarditis.

2. Calcified valves are of importance in differential diagnosis, chiefly in differentiating between luetic aortitis and aortic stenosis. In the patient with a rough aortic systolic murmur, with or without a systolic thrill, the demonstration of a calcified aortic valve conclusively proves the diagnosis of aortic stenosis. This problem frequently arises, when the roentgenoscopic examination is often of paramount importance. Similarly the demonstration of a calcified mitral valve is conclusive evidence of mitral stenosis, whether the physical signs are present or not.[13] We consider rheumatic fever to be the etiological agent in both cases and we have not yet found visible calcification in either valve to be due to luetic or arteriosclerotic changes. These findings, therefore, give us an etiological as well as a structural diagnosis.

3. Calcification of the annulus fibrosus is, in our opinion, of no clinical importance, occurring only as a degenerative change and usually therefore in elderly persons, mostly over sixty years of age. We have seen one case, however, in a male, aged twenty-four, with no known or demonstrable cause. The important point is to recognize its location and its lack of significance, although, of course, other conditions may co-exist in the same heart—angina, infarct or aortic stenosis, for example.

4. Calcification in the coronary arteries does not mean that the patient has angina pectoris. Many do have this serious disease but several patients with heavily calcified coronary arteries were free from any symptoms of coronary insufficiency. It again indicates a specific type of damage in a specific place, and can be reported only as such.

5, 6. Myocardial and endocardial calcifications are rarer findings than those above and are of doubtful clinical value. They also indicate a specific type of damage in a specific location and may occasionally be of help in explaining previous illnesses.

7. As stated before, we have not yet found a calcified cardiac tumor *in vivo* but the possibility exists of so doing with the corollary possibility of surgical removal and clinical relief.

D. The accuracy of our findings as checked by autopsies during the past ten years is very high, considering the positive findings. In every case coming to autopsy, the calcified areas or masses were confirmed with but one error in location—a calcified area in the aortic valve having erroneously been reported as being in the coronary artery. In our first report[10] several cases of calcified annulus fibrosus were erroneously interpreted as calcified valves. When the calcified area is faint it may be visible only in the right anterior oblique position, in which case we can only guess from the contour of the heart as to which valve it is. When the patient has both aortic and mitral stenosis clinically only one valve may be calcified. We assume in such a case that this indicates the earliest or original point of involvement. On the other hand, there was a high percentage of negative errors, i. e., there were many cases with intracardiac (particularly valvular) calcification which we had failed to see roentgenoscopically. If the calcified areas are not very large, or if the patient or his heart are very much oversized, we may easily overlook areas which are readily demonstrable at postmortem and on postmortem roentgenograms of the heart. Anyone wishing to familarize himself with the types, distribution, size and appearance of intracardiac

calcifications need only take roentgenograms of hearts after autopsy to be convinced of their great frequency and variety. It will be found at once that calcified coronary arteries are more frequent than all the others combined, but they are mostly not large enough or dense enough to be visualized under the roentgenoscope. Calcified valves and calcified annulus fibrosus run about equal in frequency as in our findings by roentgenoscopy. The mitral valve is much more frequently involved than the aortic valve but the calcified areas are less massive in the mitral valve and therefore frequently overlooked *in vivo*.

The location and number of intrapericardial and intracardiac calcifications we have seen in the past ten years, since we have been looking for them are as follows:

Location	*No. of Cases*
Pericardial	12
Mitral valve	56
Aortic valve	59
Coronary artery	42
Annulus fibrosus	22
Myocardial	7
Endocardial	5
Tumor	1*
	204

* Not recognized *in vivo*—not roentgenoscoped.

Doubtless some, possibly many of our cases have been lost by our imperfect cross-index system, as scarcely a week goes by without at least one intracardiac calcified area being found in our routine work. However, even this number (200) in a small 250 bed hospital in ten years conclusively proves the oft-repeated adage that one will see what one looks for. Many roentgenologists say they have never seen a calcified valve or coronary artery. It is hoped that these few directions will aid them in knowing how, when, and where to look. The "why" is up to the individual roentgenologist or his referring physician.

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ICE SKATER'S FRACTURE
A FORM OF FATIGUE FRACTURE*

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INTRODUCTION

FRACTURE usually calls to mind an incident of sudden direct or indirect violence to a bone followed immediately by rupture of its continuity, displacement, deformity, loss of function, swelling and pain. This conception is in contrast to the increasing number of descriptions dealing with relatively asymptomatic, undisplaced fractures in apparently normal bone. Depending largely on the situation or the circumstances, these lesions have been variously designated as march, shoveler's, creeping, exhaustion, insufficiency, overload and/or spontaneous fractures.

In view of our present knowledge it is generally assumed that Breithaupt's description in 1855 of swollen foot (Fussgeschwulst) was of this type of fracture in the metatarsal. For a long period thereafter the metatarsals were the only bones in which it was recognized. During this period many names were applied to this lesion such as pied forcé, Deutschlander's disease, march foot, and so forth. Many theories were propounded to explain its causation: inflammation of the tendon sheaths, traumatic inflammation of the intermetatarsal ligaments, spasm of the interossei with lymphatic and venous stasis; muscle, tendon and ligament fatigue. The more recent authors almost uniformly support the earlier authors, considering muscle, tendon and ligament fatigue as the all important factor. Bone fatigue which must ultimately occur is never specifically mentioned. Yet it is the clinical and roentgenological, palpable and visible reactions of this tissue which direct our attention to these fractures.

The Continental European writers, in contrast to the American and English authors, have recognized to much greater extent the occurrence of these fractures in the long bones and other locations. The presence of these lesions in the femur, tibia, fibula, and other areas, tends to refute those theories which are at least partially dependent for their explanation upon an anatomical arrangement peculiar only to the foot. Conversely, muscle, tendon and especially bone fatigue seems to be a broad common denominator which is applicable to almost any region where these fractures occur. Straus's statements concerning these fractures in the metatarsals seem equally applicable to other locations. He states:

> Insidious fractures of the metatarsal bones may occur after the exhaustion of the normal muscle and tendon support to the foot. Such fractures occur without obvious trauma and without sufficient immediate pain to notify the patient of the injury. Weeks later the developing callus becomes painful and calls attention to the lesion, but by this time the swelling is apt to be considered a neoplasm unless the observer is familiar with the picture of marching fracture.[3,4,15,16,18,26]

It should be emphasized here that it is extremely important to differentiate these fractures from primary malignant bone neoplasm. Neoplasm has been confused with these fractures in the tibia, in the fibula (Case 1 in this report) and in the metatarsals with amputations in the latter location because of the difficulty of differentiation.[7,16,26]

"Ice skater's fracture" is a similar fracture occurring in the lower fibula. From February 16 to February 28, 1941, three individuals with this fracture were observed. They had the following identical findings: (1) similar lesion at the same point in the lower fibula with the following distribution: one on the right, one on the left and one bilateral; (2) each was nine years old; (3) all

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were boys; (4) the skates were tubular (hockey) skates in which the attached shoe is elevated by metal tubes a considerable distance above the runner; (5) each had received his skates for Christmas, 1940 and had done his first ice skating thereafter. The bilateral case was the first observed and was the source of considerable diagnostic confusion.

PATHOLOGICAL MECHANICS

"Fatigue" is the term applied to changes occurring in repeatedly stressed metal. It has been shown spectroroentgenographically that at the point of greatest stress a slipping zone results due to regrouping of the crystalline structure. If the stress continues without rest for resynthesis, the change becomes irreversible and cracks form along the slipping zone. Similar changes have been shown in bone which has been repeatedly and usually rhythmically stressed. Various activities such as dancing, walking, running, ice skating, etc., produce this rhythmical type of stress but it is with relative infrequency that pathological changes are observed as a result. It has been shown that such lesions tend to occur at the site of greatest bending of the bone and this is determined by the forces acting upon it.

The bones in the legs of dogs have been the subject of ingenious experimental work supporting this contention. In the foreleg the radius is the main weight bearing bone. In order to subject the ulna to abnormal mechanical demand, the weight bearing capacity of the radius was decreased. This was done by grafting a metatarsophalangeal joint into a resected area in the radius, by resection of the radius, and by the formations of pseudo-arthroses in it. The ulna thereby was forced to assume a much greater share of the weight bearing. It responded by the formation of callus sometimes opposite the site in the radius, and other times at a different level; the level determined by the area receiving the greatest strain. There were no obvious fractures and the character of the lesions was very similar to those described in this paper.

Bone, however, is not dead inorganic material but is the living tissue which is continually being built up and torn down. For this reason, even though the reaction of a certain component is carried beyond the reversible stage it does not mean that this area remains at this status. Instead the localized physiological changes due to mechanical injury occur with cellular infiltration, vascularization and absorption of the injured tissue. In some instances this produces roentgenographically demonstrable areas of rarefaction in the bone. If the force continues to act during this stage of flux it is probable that visible displacement will occur. It can be shown that later this weakened area is reinforced by endosteal and extra-osseous new bone formation.[3,14,18]

TERMINOLOGY

"Fatigue fracture," qualified if desirable as to the circumstances or the location, is the term suggested to denote all of those fractures occurring in apparently normal bone which seem to be due to the summation of microtraumata from repeated subfractural mechanical injury. Pseudofractures are not qualified for this category as they are associated with a generalized metabolic disease which influences the metabolism of the skeleton. "Fatigue fracture" as mentioned above may be coupled in qualifying combinations as ice skater's fatigue fracture, march fatigue fracture, femoral, tibial, and fibular fatigue fracture.

Fatigue suggests not a sudden process but a gradual one associated with the passage of time. Despite the frequent use of the word fatigue in describing the condition of the locomotor system associated with these fractures, less informative terms in combination with fracture have been used. "Exhaustion fracture" lacks only the phonetic appeal. "Overload strain" gives no suggestion as to whether the lesion occurred instantly or whether it is static or dynamic. "Creeping fracture" is a roentgenological descriptive term stating that

the lesion on serial observation gradually traverses the bone. "Spontaneous fracture" may have two entirely different meanings. Some mean by this term the type of lesion to which this paper is devoted (the presence of asymptomatic, undisplaced fracture in apparently normal bone). Others believe this means sudden fracture by violent muscular effort of a bone which was the site of a subclinical pathological process. The presence of a pathological process such as osteomyelitis, rickets and osteomalacia in all instances of such a fracture does not seem warranted. "Insufficiency fracture" means any fracture which is due to insufficient functional capacity of the bone to meet the stresses placed upon it.[3,4,5,10,14,15,16,18]

REPORT OF CASES

Case 1. V. B., aged nine, presented himself for the first time at the Outpatient Orthopedic Clinic on February 6, 1941. Their findings were: He received ice skates for Christmas, 1940; soreness in the "right ankle" since New Years, 1941. There is no history of injury. He limps when he walks.

Roentgen Findings (Fig. 1, 2 and 3). Anteroposterior and lateral roentgenograms of the right ankle show subperiosteal new bone formation in the distal portion of the right fibula, beginning about 1½ inches from the distal end and extending about 3 inches up the shaft. There is no cuffing. There are two or three ill defined linear areas of rarefaction traversing the new bone toward the shaft and one of these apparently runs into the shaft. Opposite the greatest thickness of new bone formation there is endosteal bone proliferation increasing the density of the medullary cavity but not obliterating it. This density is oval in the anteroposterior view but appears linear in the lateral view running obliquely downward and backward.

Fig. 1. Case 1. Anteroposterior and lateral roentgenograms of the right ankle.

Fig. 2 and 3. Case 1. Anteroposterior and lateral roentgenograms of the right ankle, grid technique.

Oblique views were taken to see if the new bone uniformly surrounded the shaft as past experience had shown that in neoplasm it usually did not. These roentgenograms of the right ankle show that the shaft is evenly surrounded by the new bone (Fig. 4 and 5).

From the foregoing studies the following possibilities were considered in their order of decreasing probability: (1) subclinical infraction of the bone with resultant periosteal proliferation; (2) traumatic periostitis; (3) nonpyogenic osteomyelitis; (4) primary bone tumor of which Ewing's sarcoma would be the most probable.

Because of the multiple entities considered from the above studies and for the sake of completeness, comparative studies of the opposite

Fig. 4 and 5. Case 1. Oblique roentgenograms of the right ankle.

(left) ankle were performed on the same day. The anteroposterior and lateral roentgenograms of this ankle showed a lesion identical to that on the right (Fig. 6).

The pathological diagnosis was more obscured by the demonstration of this identical asymptomatic lesion. Congenital syphilis was strongly considered.

Fig. 6. Case 1. Lateral and anteroposterior roentgenograms of the left ankle.

Blood Kahn test to exclude lues was advised and refused. The patient returned home and was never again observed. After several letters from the Social Service Department a reply on March 3, 1941 stated: "The trouble was diagnosed as a fracture of the right ankle by the local physician and so treated." One wonders what his thoughts might have been had he also seen a roentgenogram of the opposite ankle.

Case II. R. K., aged nine, first seen on February 20, 1941. He had been ice skating vigorously on the evenings of February 5, 6 and 7, 1941. On February 8, 1941, he complained of pain in both ankles, more severe on the right. He gave no history of sudden severe trauma. Examination by the family physician on February 11, 1941, showed no swelling or redness or evidence of fracture in the region of the right ankle. There was only slight pain on February 12, 1941. On February 18, 1941, there was slight swelling just above the outside of the ankle. The past history was irrelevant except that he has had adequate amounts of cod liver oil and orange juice since infancy and that he eats a well balanced diet and is taking vitamin capsules. Examination showed a slight non-tender doughy swelling just above the

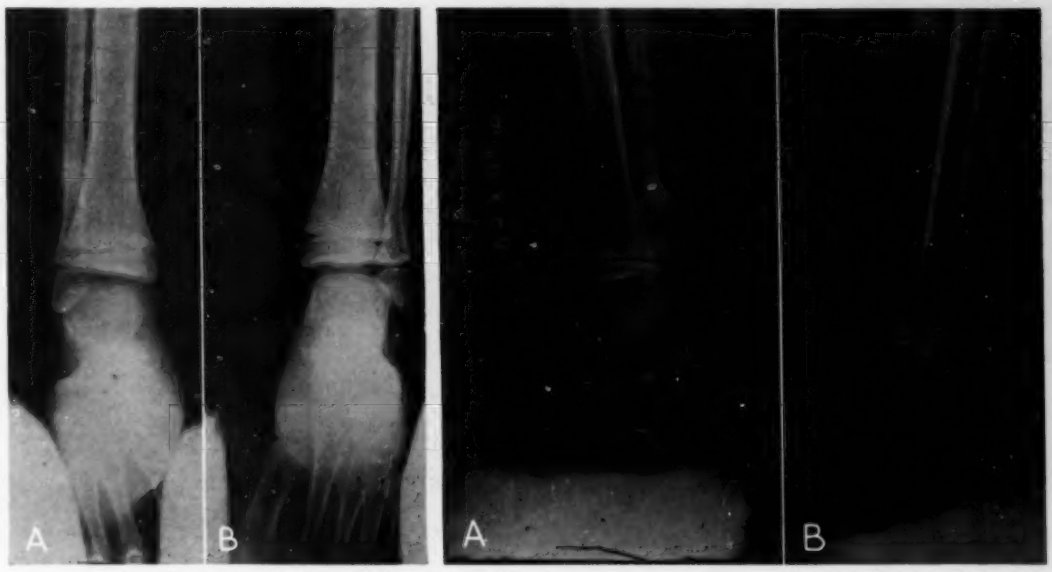

Fig. 7 and 8. Case II. Comparative anteroposterior and lateral roentgenograms of both ankles. *A*, right ankle; *B*, left ankle.

lateral malleolus. Blood Kahn reaction was negative.

Anteroposterior and lateral roentgenograms of both ankles show findings similar to those in Case I (Fig. 7 and 8).

In Case I no clinical history was available at the time of interpreting the roentgenograms. The same was true of Case II but on seeing a lesion which gave exactly the same appearance as Case I complete clinical information on both cases was requested. The marked similarity of the lesions and histories made it possible to render initially the opinion of "ice skater's fracture" in Case II and to correct the diagnosis in retrospect on Case I.

Check-up studies were made four months

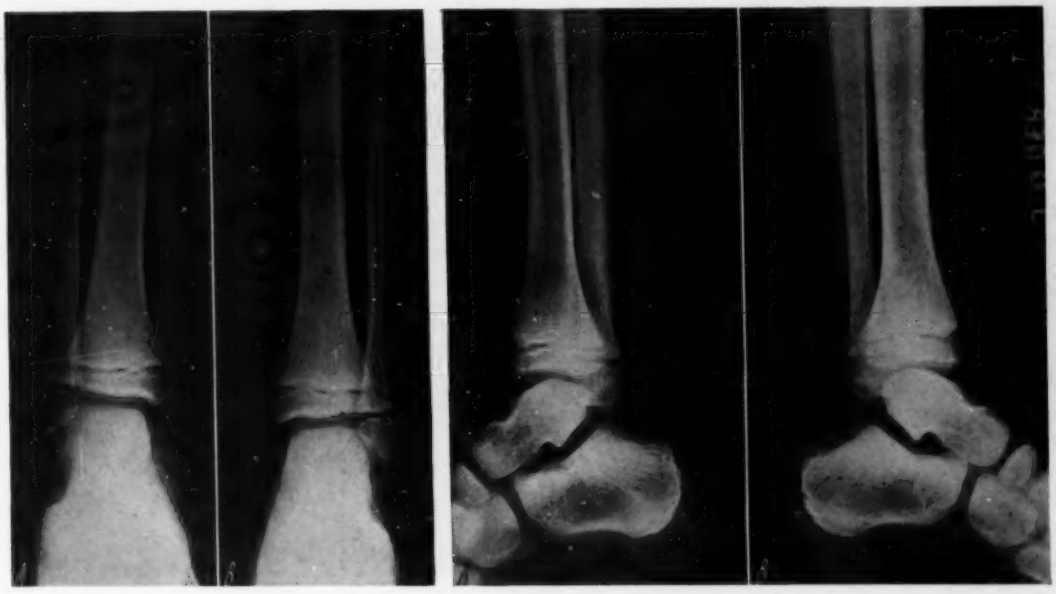

Fig. 9 and 10. Case II. Comparative anteroposterior and lateral roentgenograms of both ankles four months later. *A*, right ankle; *B*, left ankle.

Fig. 11. Case III. Original anteroposterior and lateral roentgenograms of the left ankle, taken elsewhere.

later, and included anteroposterior and lateral roentgenograms of both right and left ankles (Fig. 9 and 10). These show a spindle shaped thickening of the shaft of the distal right fibula in the anteroposterior view and in the lateral view thickening of mainly the posterior cortex at the same level. In both views there is a definite narrowing of the diameter of the medullary cavity at this level. This was considered evidence of solid healing at the fracture site.

Case III. P. K., aged nine, was first seen by us on February 28, 1941. He had skated every day after school from January 28 to February 9, 1941, and on February 10, 1941, his left leg became sore and the patient limped. In spite of this the patient skated on the afternoon of this day. The same evening the mother noticed that the leg was somewhat swollen and she soaked it in epsom salts and applied liniment. Patient walked to school on February 11, 1941, but remained home the following day. He walked to school the rest of the week and on February 18, 1941, his parents took him to a non-medical person with an x-ray machine. This same individual made a second study on February 28, 1941, on the same day the patient was referred to us by an orthopedist. There was a slight, non-tender doughy swelling along the lateral aspect of the lower fibula. The past history was irrelevant except that he had done some roller skating in the summer of 1940. Blood Kahn reaction was negative.

The roentgenograms made elsewhere were obtained and reviewed. These consisted of anteroposterior and lateral views (Fig. 11) of the left ankle, undated, reputedly taken on February 18, 1941. In the anteroposterior view about 3 inches from the distal end of the left fibula there is a very faint fissure fracture traversing the medial cortex associated with a minute offset medially of the distal fragment. There is a transverse band of endosteal new bone formation at the same level. In the lateral view the density is of the same character and runs slightly downward and backward, associated with a minute offset of the distal fragment anteriorly. In both views extending in both directions for about 1½ inches is a very faintly calcifying periosteal new bone formation.

Anteroposterior and lateral roentgenograms of both ankles were taken elsewhere and in our office ten days later (February 28, 1941) (Fig. 12, 13 and 14). These show in addition to the

Fig. 12. Case III. Anteroposterior and lateral roentgenograms of the left ankle, taken elsewhere, ten days after Figure 11.

Fig. 13 and 14. Case III. Our comparative anteroposterior and lateral roentgenograms of both ankles taken the same date as Figure 12. *A*, right ankle; *B*, left ankle.

above findings considerable increase in the thickness and density of the subperiosteal new bone, and the slight offset of the distal fragment is more obvious as the tibia is not superimposed upon the fibula. Conclusion: ice skater's fracture.

It is suggested that this boy may already have had a lesion present and that the additional skating on February 10, 1941, may have been enough to cause the minute displacement. It should be noted that there is no displacement in the other two cases.

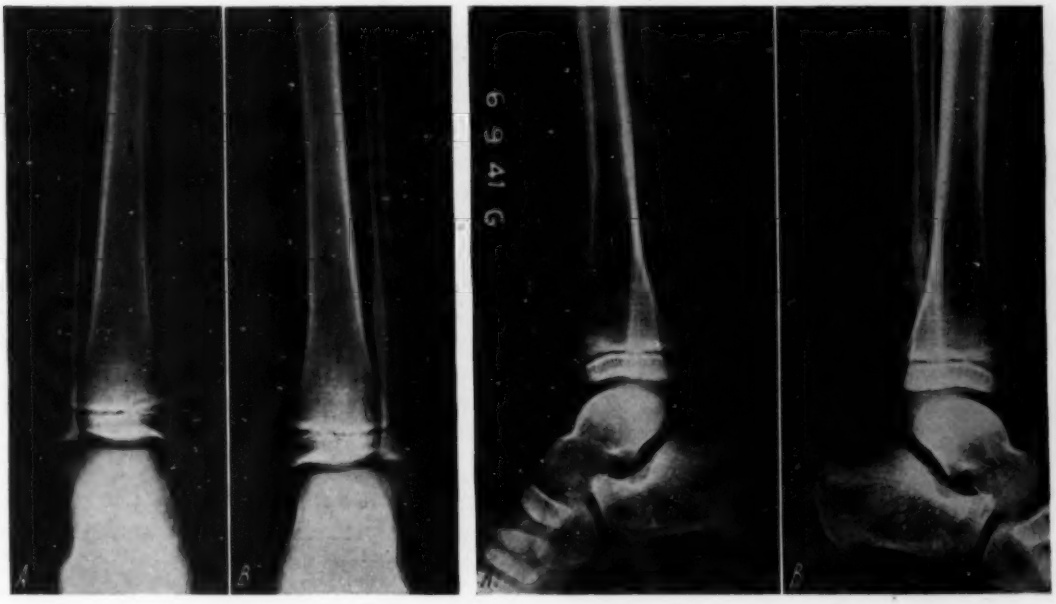

Fig. 15 and 16. Case II. Comparative anteroposterior and lateral roentgenograms taken four months later. *A*, right ankle; *B*, left ankle.

Check-up studies (Fig. 15 and 16) approximately four months later show the same findings as the check-up studies on Case II.

ANALYSIS OF THE MECHANISM OF ICE SKATER'S FRACTURE

An attempt was made to explain the production of these lesions. As mentioned previously, these fractures tend to occur at the point of greatest oscillatory amplitude of a bending bone. The fracture lines in the cases reported herein all ran downward and backward and occurred at the same level. The investigation proceeded along three lines: (1) the motions of ice skating, particularly at the ankle; (2) the anatomy of the foot and ankle; (3) the explanations offered for similar fractures occurring immediately as the result of violence.

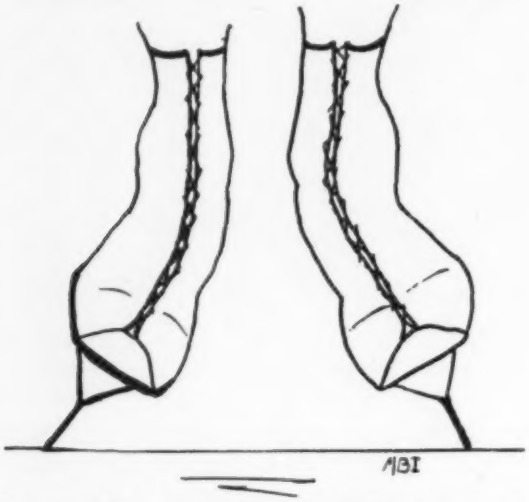

FIG. 17. The eversion leverage of the skate on the ankle, especially in inexperienced skaters.

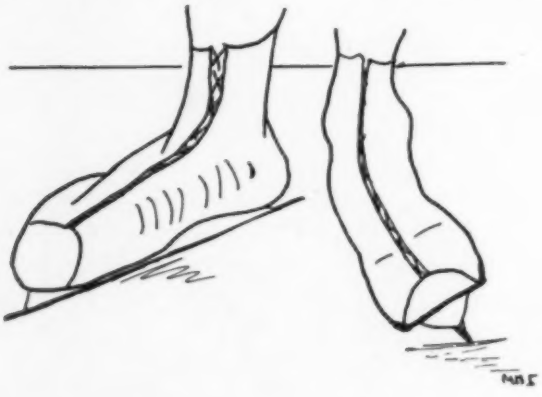

FIG. 18. The eversion of the ankle in the shove-off propelling skate.

Ice Skating. No source analyzing the motions of ice skating was found. Observation showed that these motions were extremely complex and difficult to describe. The following observations were made: (1) the skate markedly increases the inverting or everting leverage on the foot; (2) considerable external rotatory force is exerted on the ankle but the foot is kept in a fixed position by the skate on the ice; (3) eversion is an extremely prominent factor. There is marked impact in eversion by the shove-off propelling skate. Forward skating cannot be done in inversion but can be done in neutral position or eversion. The more inexperienced or tired the skater, the greater the eversion in which he skates (Fig. 17, 18 and 19). This can at times be sufficient to permit both the runner and the instep of the same skate shoe to simultaneously drag on the ice.[24]

FIG. 19. Shift of entire weight to one ankle when propelling skate lifts from the ice.

Anatomy. A detailed discussion of the anatomy of the ankle joint will not be given but only those facts which seem pertinent

to the present discussion. The fibula is one-fourth as wide at its narrowest point, 2 to 3 inches from its distal tip, as it is at the widest part of the lateral malleolus. At this narrow area it is bound to the tibia by only the thin, strong, interosseous membrane which runs obliquely backward from the tibia. This membrane is perforated at this level by blood vessels. It extends upward to just below the knee joint and downward to blend with the ligaments of the tibiofibular articulation. The distal convex medial surface of the fibula fits into a concavity on the distal lateral surface of the tibia where they are bound together by the strong tibiofibular ligaments into a syndesmosis.

The mortise formed by the malleoli of these two bones has no muscles on either side of it. It narrows from front to back as does the superior surface of the wedge-shaped talus which fits into it. The lateral malleolus compared with the medial malleolus has thrice the articular surface with the talus, and measured from the ankle joint cartilage is twice as long.

The ankle joint is a true ginglymus permitting only dorsiflexion and plantar flexion. Any potential side to side motion at the talotibial articulation is due to stretching of the ligaments of the tibiofibular syndesmosis. In dorsiflexion the wedge-shaped talus can separate the malleoli by a gliding at the syndesmosis and an outward rotary motion and slight bending of the fibula.

The forward and backward sway of the body is controlled at the ankle joint. The side sway is controlled mainly at the subastragaloid joint assisted by the talonavicular and the calcaneocuboid articulations. It is here that inversion and eversion of the foot takes place.[6,9,11,17,19,21,24,25]

Ankle Fractures. As skating in inversion is impossible, no rhythmical stress could be applied by this force. The marked prominence of eversion during skating plus the fact that over 75 per cent of ankle joint fractures are eversion external rotation injuries led the investigation in this direction. Analyses have been made to determine the static forces of the ankle joint mortise with the foot in eversion. The tibia and fibula being bound together act as a weight bearing column. With the foot in neutral position the weight is distributed upward through the shaft of the tibia. With the foot in eversion the eccentricity toward the fibula is 50 per cent. The weight bearing line shifts laterally and runs approximately along the course of the interosseous membrane. This markedly increases the pressure against the lateral malleolus. In resolving the articular areas of the ankle joint into square inches of surface, it has been shown that in eversion the weight of a 150 pound man exerts a force of 600 pounds per square inch against the lateral malleolus. In addition to this compression force there is the extremely important torsion due to the external rotation. This force tends to cause the quadrilaterally shaped talus to spring the ankle joint mortise (Fig. 20).

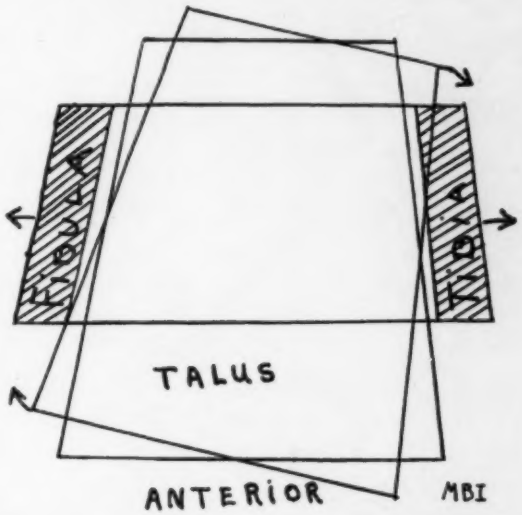

Fig. 20. Diagram of the rotating talus trying to spring the ankle joint mortise by rotation (adapted from Stevens[25]).

There are two main types of eversion external rotation fractures. Type 1: The foot is in eversion but not fixed by the topography. There is external rotation at the ankle joint with the body weight lying medial to this foot. The quickly acting force causes

the talus to act as a pinch lever breaking the rigid mortise at the ankle joint and usually fracturing both malleoli. Type 2:

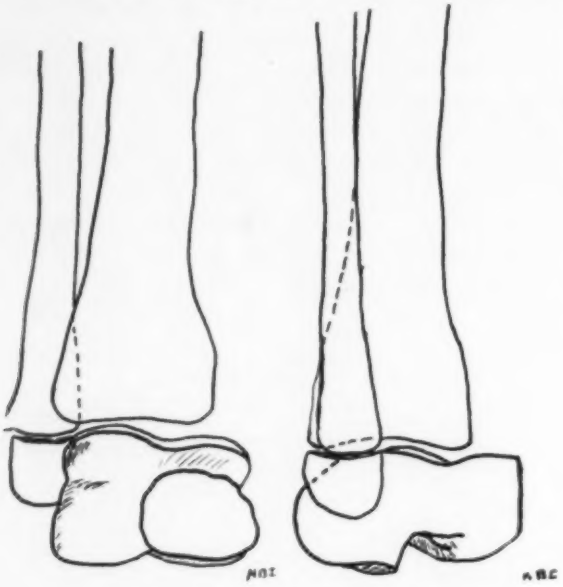

Fig. 21 and 22. Diagram of normal ankle joint.

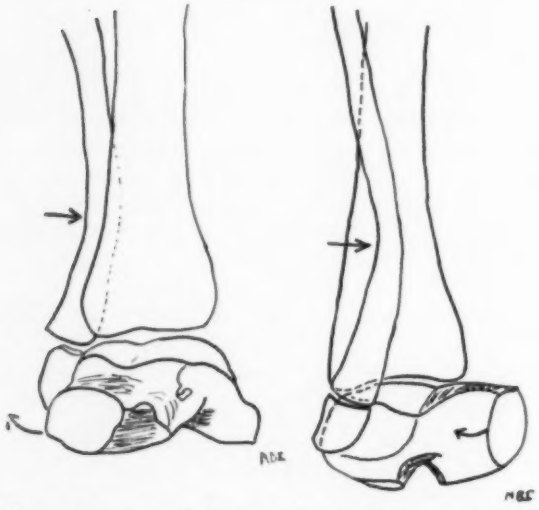

Fig. 23 and 24. Diagram of rotating talus bending and fibula with fulcrum at tibiofibular syndesmosis—exaggerated.

The foot is fixed by the topography and the body weight falls lateral to it. This type of force tends to be the more slowly acting and frequently the internal malleolus is not damaged. The foot is under the compression of the body weight which equally compresses the talus into the ankle joint mortise. The resistance of the topography (the ice skates fixed against the ice) prevents the foot from rotating. The ankle joint mortise, therefore, rotates on the talus. The fulcrum is at the level of the tibiofibular ligament or higher; as the fibula is much thinner 2 to 3 inches from its distal tip the Type 2 forces tend to cause it to break much more frequently in this region.[1,2,13,20,23,25,27,28]

Applying the Type 2 forces to the present cases two possibilities present themselves: (*a*) The eversion and external rotatory force of the talus acts against a non-

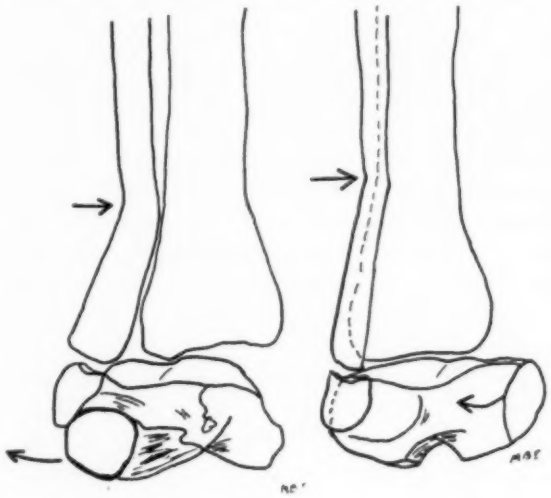

Fig. 25 and 26. Diagram of rotating and lateral gliding talus due to stretching of tibiofibular ligaments, bending fibula with fulcrum at interosseous membrane—exaggerated.

fracturing malleolus and an unyielding tibiofibular ligament. This produces a lever of the first order where the power is applied to one side of the fulcrum (the tibiofibular syndesmosis) and the resistance is on the other side of the fulcrum. The fibula proximal to the ligament offering the resistance would tend to bend inward and forward with the greatest bending at its weakest point. The direction of the interosseous membrane would permit such bending to occur (Fig. 21, 22, 23 and 24). (*b*) The tibiofibular ligament may give elastically at the syndesmosis, permitting the talus to rotate and glide laterally. The external

malleolus would be forced not only backward but outward. As stated in the discussion of the anatomy, the interosseous membrane runs backward from the tibia and would not permit any backward displacement of the fibula above the syndesmosis. Therefore the fibula would be bent again at its weakest point. A lever of the second order would be formed, the interosseous membrane acting as the fulcrum, the resistance that of the fibula to bending and the power again applied distally by the talus (Fig. 25 and 26).

CONCLUSIONS

1. "Ice skater's fracture" belongs in the group of fractures occurring insensibly in seemingly normal bones and resulting from the summation of microtraumata due to repeated mechanical injury.

2. It is suggested that all fractures of this nature be included under the broad head of "fatigue fracture."

3. Three cases of ice skater's fracture are reported.

4. An attempt is made to rationalize the pathological findings in these cases on a mechanical anatomical basis.

I wish to express my appreciation to Drs. Hodgen, Aitken and Batts for the use of this material from their orthopedic practices.

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ADAMANTINOMA*†
REPORT OF EIGHT CASES

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ADAMANTINOMA is an epithelial tumor of basal cell type, usually considered as benign, but a review of the literature reveals a surprisingly large number of cases with evidence of local malignancy, invasion of neighboring organs, and fatal termination. At least 14 cases had been reported with regional or distant metastasis. Although still considered as a rarity, there are 400 to 450 cases recorded in the international literature.

They occur most often in the jaws. The mandible is involved most frequently—in about 80 to 85 per cent of the cases reported. Besides those occurring in the jaws, there are a few case reports in the literature where the pituitary body,[6,7,9,24,28] lip,[36] cheek,[8] and tibia[29] were the site of true adamantinomas. Six of our 8 cases originated from the mandible, 1 from the maxilla, and 1 from the pituitary body.

The age incidence of this tumor is wide. There are cases on record in every decade of life, but the large majority—approximately 70 per cent—occur between ten and thirty-five years of age. At least 1 case was reported[15] occurring in a newborn baby boy.

The female sex is slightly more often affected than the male; the ratio is about 55 to 45. However, this ratio was reversed in our series, as 5 of the 8 patients were males. According to Kegel[20] the Negro is four times more often involved than any other race. Only 1 of our patients was Negro and the remaining 7 were white. The ratio of the white and colored population in Oklahoma is 12.3 to 1.

It is interesting that this tumor is known in the animal kingdom too. Bauer[2] observed a case occurring in a horse; Kaufmann[19] saw one in a cow.

The tooth, with the exception of the enamel organ, is composed of connective tissue. The enamel organ is a derivative of the oral epithelium. The dental ridge is formed in the second fetal month by infolding of the oral epithelium, a process similar to the formation of glands from the ectoderm. The enamel organ of each tooth forms from the dental ridge as pedunculated epithelial buds embedded in the mesoderm. In the third fetal month the mesoderm invaginates the base of the enamel organ, forming a bell shaped structure from the rounded epithelial bud. Histologically, the enamel organ is composed of an outer and inner layer of epithelium, the so-called outer and inner tunics. There are between them the stellate cells with some mucoid material in the intercellular spaces. The invaginated connective tissue becomes the dental papilla. The outer and inner tunics become compressed at the base of the enamel organ by the invagination of the dental papilla, and they thus form the sheath of Hertwig.

The adamantinoma of the jaw may originate from one of the following sources which can all be traced back to the parent cell, the oral epithelium:

1. Oral surface epithelium retaining the potential ability to specialize into ameloblast.
2. Mucous glands of oral epithelium.[4]
3. Epithelial cell inclusions along the teeth, the so-called "paradental epithelial debris of Malassez."[22]
4. Enamel organ or the primitive enamel anlage of a degenerated dental follicle.
5. Follicular cysts.

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The basal cell origin of these growths was stated first by Hungarian authors, Krompecher[21] and Bakay.[1] Recently Cahn's studies[5] led to the same conclusion. He believes that the adamantinoma is "really an intraosseus basal cell epithelioma."

Several tumors of the pituitary body were reported having the exact microscopic appearance of an adamantinoma. Mihalkovics[25] of Budapest as early as 1875 published his original study on the embryology and the developmental anatomy of the pituitary body, and demonstrated on dogs the ectodermal origin of the anterior lobe. Later, Erdheim,[10] while studying the epithelial rests of the cervical organs, found epithelial cell occlusions along the anterior surface of the infundibulum and beneath the capsule on the upper surface of the anterior lobe of the pituitary body. Then for further observation he made serial sections of the pituitary body in 12 normal adults. His studies confirmed Mihalkovics's findings, who demonstrated that the upward and forward rotation of the anterior lobe of the embryonal pituitary body carried the area of attachment of the hypophyseal duct to exactly the same location where the epithelial cell nests were found by Erdheim in 10 of his 13 cases, representing 77 per cent.

Approximately 16 adamantinomas of the tibia have been recorded up to December, 1940. No sound theory of the origin of these tumors has been found yet. According to Oberling, Vermes and Cheverau[27] because of certain embryonal malformations, some epithelial cell inclusions—having the potential capacity to specialize into ameloblasts—occurred in the tibia, and later they gave rise to an ameloblastoma (adamantinoma). Sutro and Pomerantz[32] transplanted the soft tissues of unerupted teeth, surgically removed, to the tibias of 6 kittens weighing about 1 kilogram each. Their histological study demonstrated that the autogenous tooth germ elements transplanted into the tibial marrow can regenerate. Hertwig's sheath survived and proliferated in its new environment. Trauma has been considered as an exciting factor here as well as in all bone tumor cases.

Microscopically, an adamantinoma, wherever originated, is composed of groups of epithelial cells in a stroma of normal connective tissue and reveals the following histopathological picture: (1) The peripheral layer is composed of a single row of epithelium forming a palisade-like structure representing the adamantoblastic layer of the enamel. (2) The middle layer is made up of vesicular cells corresponding to the reticulated enamel cells. (3) The center of the cell nest is composed of stellate cells representing the stellate cells of the enamel organ similarly located in the central zone.

Macroscopically, there are two main types of adamantinoma: namely, the solid and cystic types. Most of the authors believe that all adamantinomas start out as a solid growth and the cyst formation is simply a degenerative process occurring inside the epithelial strands of a solid growth at a later stage of the tumor. Besides this degenerative liquefaction, there is secretion of the cylindrical cells into the cavity. These two processes, then, are responsible for the transformation of a solid growth into a polycystic one. Bauer[2] does not support this theory. He believes that there are solid and cystic adamantinomas which keep their original form, but he also admits that cystic degeneration may occur in a solid adamantinoma. The cystic type is far more common and reaches a much larger size than the solid ones.

According to Thoma,[33] an ordinary adamantinoma grows by proliferation of the epithelium in the marrow spaces and expands the bone by newly formed cysts and lobes. Spring[31] reported cases where true infiltration of the bone and destructive resorption occurred. Infiltration of the soft tissue was reported in 3 cases by L'Esperance.[22]

Clinically, adamantinoma of the jaw is characterized by its long duration. Being a painless, slowly growing, centrally located tumor, it therefore produces practically no symptoms or pain before a noticeable size is reached. Pain, if present, is due to pres-

sure. It is not generally known that a loose or painful tooth precedes the noticeable growth. Jacobs[18] stated, "There is no record in the literature of these tumors occurring in a mouth with a full set of erupted teeth, unless there was present an impacted or otherwise malposed supernumerary tooth." Sometimes a fistula develops in the buccal cavity and discharges straw-colored clear fluid. On palpation of a large tumor crackling of the distended, thin bony shell may be heard. When the tumor originates from the maxilla, its extension or invasion into the antrum and nasal cavity is just a matter of time.

The roentgen examination is far more important and helpful in the diagnosis of these cases than is generally believed. The solid adamantinoma produces a monocystic appearance on the roentgenogram. It usually can be differentiated from odontogenic cysts by the appearance of the border of the bone defect. It is smooth and continuous in odontogenic cysts, but interrupted by small niches in adamantinoma which produce a more or less lobulated appearance and a few fine bone trabeculae at the anterior and posterior end of the lesion.

The polycystic type reveals a honeycomb appearance in the early stage and later it is characterized by the huge distention of the bone by a cystic defect showing several round compartments. A central giant cell tumor does not reach as large a size as an adamantinoma. A chondroma produces fine straight bone trabeculations which do not tend to form round cystic compartments.

Sometimes the adamantinoma forms a huge single cavity resembling a dentigerous cyst. It can easily be differentiated by the appearance of the border of the bone defect as was discussed above.

Adamantinoma as well as a dentigerous cyst may contain a tooth, though it is far more common in the latter. In Hildebrand's case[16] about 200 teeth were found in an adamantinoma. According to Thoma[33] the location of the tooth in the cyst may serve as a diagnostic aid. In a dentigerous cyst the crown of the tooth is pushed away from the gingiva by the cystic pressure to the periphery of the cavity. It may be located anywhere in an adamantinoma because it is imbedded and fixed in the tumor tissue. Only 1 of our cases contained a tooth, which was located at the bottom of the tumor, but the lobulated and polycystic appearance of the bone defect led to a correct roentgen diagnosis.

A review of the literature revealed only 14 cases with regional or distant metastasis. The following is a list of adamantinomas with regional and distant metastasis recorded in the literature:

Case 1. Eve[11] reported a case occurring in a white woman, aged sixty. She had an adamantinoma in the lower left jaw which had been present for thirteen weeks, was operated upon, and died from postoperative bronchopneumonia. At autopsy metastases were found in the lumbar lymph nodes near the suprarenals.

Cases 2 and 3. Ewing[12] saw 2 cases in which metastases were present in the cervical lymph nodes and lung. (No detailed description of the cases was given.)

Case 4. Gentsch's case[13] occurred in the left maxilla of a forty-four year old white man, eleven years after an injury caused by shrapnel. The tumor invaded the lymph nodes, sphenoid sinus and malar bone.

Cases 5 and 6. Havens[14] reported 2 cases: 1 occurred in the right mandible of a white woman, aged forty-nine, with metastases to the right submaxillary region. No description of his second case was given in his paper.

Case 7. Heath[15] has seen a white man, aged sixty-seven, with adamantinoma of both mandibles of twenty-eight years' duration. The right jaw healed after operation, but the tumor of the left jaw recurred and metastases were found in the deltoid fossa and pelvis.

Case 8. Horsley's case[17] occurred in the right mandible of a white woman, aged thirty-nine, and had a duration of twenty years. It recurred two years after operation. Metastases were found in the cervical lymph nodes and lung.

Case 9. New[26] reported a case of adamantinoma of the lower jaw with metastasis to a submaxillary gland with no recurrence after the removal of the primary growth and gland. No detailed description of this case was given.

Case 10. One of Simmons'[30] cases occurred in the left lower jaw of a white woman, aged thirty-seven. The tumor was of fifteen years' duration, was oper-

ated upon and recurred four times. Finally metastasis was found in a cervical lymph node.

Case 11. Simmons' second case was found in the right lower jaw of a white male, aged thirty-seven. It had a duration of fifteen years. It was operated upon but recurred, and metastases appeared in the cervical and submaxillary lymph nodes and in the lungs.

Case 12. Spring[31] reported a case which occurred in the right lower jaw of a five year old white boy. At the age of seven it was the size of a hen's egg. He was operated upon seven times because of recurrences. Metastases were found in several cranial bones, and there were several subcutaneous metastatic nodules on the forehead. However, all of these metastatic growths disappeared after roentgen treatment.

Case 13. Vorzimer and Perla[34] saw a thirty-eight year old white man with adamantinoma of the right maxilla of thirty-one years' duration. He was operated upon and had recurrence five times with invasion of the antrum and nasal septum. Finally, radical excision followed by radium treatment brought about a cure. Three years later metastasis developed in both lungs.

Case 14. Weissenfels' case[35] occurred in the left lower jaw of a white male, aged twenty-six, and had a duration of fourteen years. It was operated upon and recurred; metastases were found in the cervical lymph nodes, skin, lung, and submaxillary lymph nodes.

In this study we do not intend to review those numerous cases from the literature which showed only local evidence of malignancy. Many writers on this subject agree that they, as well as those cases with metastasis, exhibit an atypical histopathological picture characterized by an increased cellularity of the stroma and predominance of the cuboid over the stellate and cylindrical types of epithelial cells. Our Case 1 who had pulmonary metastasis showed a similar microscopic picture.

Several authors have criticized this term "adamantinoma" and suggested what they consider more proper names. Others believe it is justifiable because of long usage. We feel that this term is not only misleading, since adamantinoma never forms enamel, but it is meaningless for the great majority of the profession with the exception of the pathologist and oncologist. Probably adamantin epithelioma—a term already used a few times—would be the most proper name for these tumors. It would indicate the histogenesis and potential malignancy of these cases. For historical reference we note that Krompecher suggested a not generally known name, "basiloma," indicating the basal cell origin of this tumor.

REPORT OF CASES

Case 1 (Hospital No. 82247). J. H. M., a white farmer, aged fifty-five, was admitted August 19, 1935, with complaints of a mass and draining lesion in the floor of the left side of the mouth.

The onset was eight years previous to admission, at which time he noted a small swelling in the alveolar process on the left. This mass grew gradually, giving no pain or discomfort until two years prior to admission when he reported to the outpatient department but refused any kind of surgery, even removal of the tooth adjacent to the tumor. The mass at that time was cystic. Later he had two molar teeth extracted with resultant drainage of thick greenish-yellow material from the ruptured cyst. Some improvement followed.

Physical examination revealed a smooth tumor mass measuring 5 by 5 by 8 cm. on the left in the floor of the mouth, apparently attached to the inner side of the mandible. The mass was non-tender, painless and displaced the tongue medially. Two or three hard shot-like lymph nodes were present in both submaxillary regions. Aside from a marked kyphosis of the dorsal spine the remaining physical examination revealed nothing abnormal.

Laboratory findings: red blood count, 4,690,000, hemoglobin 95 per cent, white blood count 5,200, neutrophiles 76 per cent; Wassermann reaction and urinalysis were negative. Eleven days after admission, the patient was operated upon and an ovoid, hard, nodular tumor bound down firmly by dense adhesions was removed from the floor of the mouth on the left.

Microscopic examination showed the tumor composed of considerable embryonic tissue with dense fibrous trabeculae and scattered irregular masses, groups and strands of poorly differentiated, somewhat gland-like epithelial cells. Some areas showed a tendency to alveolar structure and other areas showed dilated acini resembling cystic formation: Microscopic diagnosis: Adamantinoma.

The patient made an uneventful recovery.

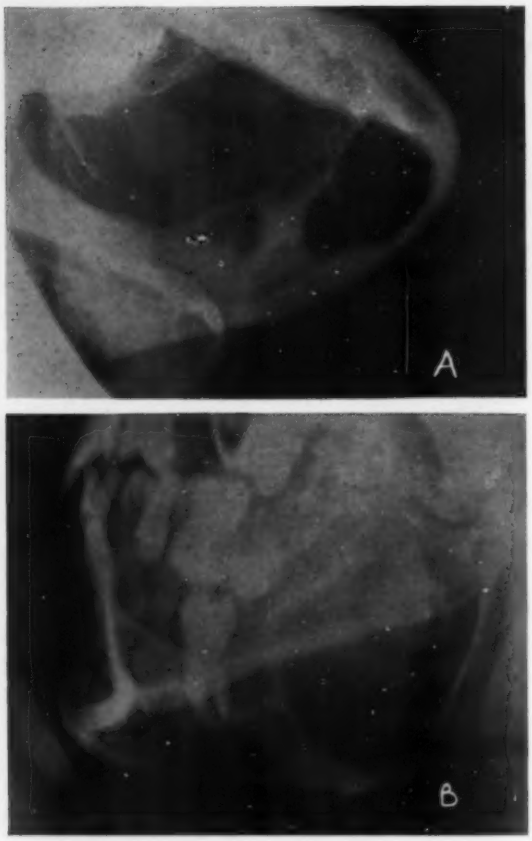

Fig. 1. *A*, Case I. Polycystic defect in mandible close to symphysis. *B*, Case VI. Large bone defect in posterior part of mandible extending into ramus. Note small cyst anterior to large defect.

Three years and three months after operation he returned to the outpatient department with recurrence of the tumor. Roentgen examination showed a large multilocular defect of the left mandible near the symphysis. The patient was advised to have an operation and was sent to another hospital by his county commissioner where the tumor was curetted. Two months later he was referred to us for postoperative roentgen therapy. He received 1,600 r (200 kv. and Thoraeus A filter) to each of the two fields, using the crossfire method.

He returned three months later, weak, having lost 20 pounds in weight. Roentgen examination revealed extensive bilateral pulmonary metastasis. His liver was markedly enlarged. No other sources of these metastatic lesions were found by physical, roentgen or laboratory examinations. Neither gastrointestinal nor the genitourinary tract revealed any evidence of a pathologic condition.

A punch biopsy from the pulmonary lesion showed that the tissue consisted almost entirely of necrotic acellular material with an occasional fragment or nucleus of a disintegrated cell. The moderate deposition of pigment was apparently hematogenous.

The patient died at home in a few weeks after his last visit. In view of the early regional glandular metastases, recurrence of the tumor and negative findings of the rest of the body, we believe that these metastases originated from the recurrent adamantinoma.

Case II (Hospital No. 98914). D. B. T., a white female, aged fifty-three, well developed, obese (married to a farmer), first noticed in July, 1937, a small, firm, non-tender lump arising from the top of the gum in the lower right premolar area. All teeth had been removed eight years previously (1929) because of general ill health. There had been no trouble with teeth in this area prior to extraction. She had been wearing a denture since then but only upon going away from home. She stated that plates had not been in place more than three months total. The mass continued to enlarge but because it was not painful she did not have it examined until it began to interfere with the wearing of her denture four or five months before admission. At this time she consulted a "cancer doctor" (evidently a quack) who informed her that

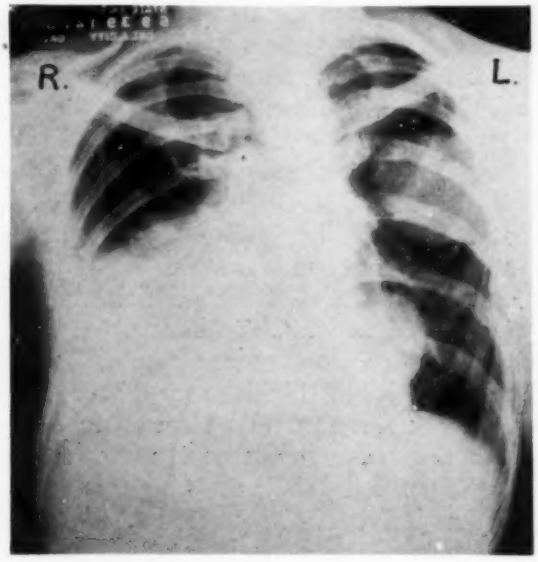

Fig. 2. Case I. Large round metastatic growths in left lung field. Small round metastasis in right apex. Diffuse metastatic growth at right base.

she did not have a cancer and did not advise treatment. Later, her dentist made a roentgenogram and referred her to our hospital.

Examination revealed a firmly fixed, non-tender mass 3 cm. in diameter involving the gum and mandible in the right lower premolar area. Mass was slightly softer on top. The rest of the body was essentially negative. Roentgen examination of the jaw revealed a multilocular cystic area measuring 3 cm. in diameter at the anterior part of the right mandible near the symphysis.

Laboratory data: red blood count 3,800,000, hemoglobin 72 per cent, white blood count 6,000, and neutrophiles 64 per cent. Wassermann reaction and urinalysis were negative. Patient was operated on October 24, 1938. A large quantity of caseous material was removed from the cystic cavity in the lower right portion of the mandible. In addition, a part of the fibrous lining was stripped. The bone was left smooth. There was a perforation, the size of a dime, through the lingual plate of bone.

On microscopic examination sections showed dense, fibrous tissue and definite tumor formation. This was composed of cells which varied in their morphology but resembled very closely stratified epithelium. The basal cells predominated and the architecture was in the form of masses and sheets with small scattered isolated groups. In some areas the basal cells formed alveolar-like structures in which the lining cells were several layers thick on the outer portions showing a gradation into spindle type cells. There was a tendency in some areas toward epithelial pearl formation. The cells were fairly well differentiated and showed no definite evidence of malignancy. Diagnosis of adamantinoma was made.

Fig. 3. Case III. Large polycystic defect involving entire right mandible. Note fully developed tooth at base of cyst.

Fig. 4. Lateral roentgenogram of Case III.

On the eighth postoperative day, a course of roentgen therapy was given through one lateral and one inferior field, 1,600 r with 200 kv. (150 r daily) to each field.

The patient made an uneventful recovery and when last seen in June, 1940, had no complaints. Neither physical nor roentgen examination revealed any signs of recurrence or metastasis. The mandible healed completely.

Case III (Hospital No. 95940). B. M. N., a white female, aged nineteen, was referred to the hospital because of swelling in the right side of the jaw. Patient stated that two years before admission the lower right second molar was extracted and a month later she noted swelling of the gum at that area. Subsequently, this ruptured and drained bloody material at irregular intervals. At about the same time she noticed

an enlargement at the angle of the mandible which had gradually increased in size.

Examination revealed a large, hard, firm, fairly well rounded, non-tender mass 8 by 9 cm. extending 2 cm. from the angle of the mouth to the posterior surface of the ramus on the right. The skin was freely movable over the mass. Internal examination showed that the second and third molars were absent; the alveolar ridge was expanded. Just posterior to the first molar was a small mass, 2 cm. in diameter, having the appearance of necrotic tissue.

General physical examination and past history were essentially negative except for one brother having died of gastric cancer. Roentgen examination showed a huge, 5 by 7 cm. in size, multilocular cystic expansion of the body of the mandible extending from the first bicuspid to the sigmoid notch. The crown of a well developed molar was lying within the cavity.

Under general anesthesia a large amount of inflammatory tissue, three definite cysts containing fluid, and three teeth including the one within the cavity were removed.

Microscopic examination showed an abundance of very dense connective tissue. Scattered through this were irregular gland-like structures in which the lining epithelium was poorly differentiated and thickened in many places. Structures varied greatly in size, some cord-like in appearance, while others were elongated. In addition, there were fibrous proliferations around many of the tumor structures. Blood vessels were scanty. Diagnosis, adamantinoma.

The patient made an uneventful recovery. Roentgen therapy was started on the ninth postoperative day. A total dose of 1,000 r per field was given, using 200 kv., to the region of the right mandible. It was given through two fields, one lateral and one from below upward.

The patient failed to return. Our letters were unclaimed.

Case iv (Hospital No. 55891). B. C. Five years before admission, patient's upper left molar was removed because of tooth-ache. There was no relief of pain. Soon after, a small mass was noted on the left cheek which increased in size slowly. Pain disappeared and did not bother patient until a year before admission. Pains were dull in character and worse at night. Her nose became obstructed about the same time. Patient had a weight loss of 30 pounds during these five years and gave a history of lues of a two year duration.

Physical examination revealed a moderately well developed, poorly nourished colored female, thirty years of age, not acutely ill. There was a well circumscribed, moderately hard tumor on the left face attached to the skin of the maxilla, extending about 2 cm. in front of the ear to the midline and from the lower eyelid to the margin of the mandible. The left naris was occluded, nasal septum was displaced to the right and the hard palate was pushed downward. Left upper molars were absent. Canine and bicuspids were displaced downward. The surface of the mass was irregular on palpation and the consistency varied from stony hard to soft in different areas. The overlying mucous membrane was reddened and spongy. The skin over the tumor mass showed large areas of exfoliative dermatitis. Similar skin changes were observed on the dorsum of both hands, feet, forearms and around the neck. The mass was slightly tender only in front of the ear. Bloody material was draining from the left upper gum. General examination and family history were essentially negative.

Laboratory findings: red blood count, 4,480,000; hemoglobin, 70 per cent; white blood count 8,200; Wassermann reaction and urinalysis were negative.

Roentgen examination showed marked destruction and distention in the molar region of the left maxilla. A biopsy was taken and microscopic examination showed adamantinoma. This case was registered under No. 1390 by the Registry of Bone Sarcoma of the American College of Surgeons.

The patient refused treatment. We were unable to get information concerning the course of her disease.

Case v (Hospital No. 76124). W. O. H., a white male, aged fifty-eight, laborer, was first seen in the out-patient department on February 28, 1939, complaining of a mass in the left mandibular region which had gradually increased in size since onset eighteen months previously. Three months before the first visit a lesion appeared on the buccal mucosa opposite the mandibular mass.

Physical examination showed a firmly adherent tumor mass 5 by 8 cm. at the angle of the left mandible extending upward along the ramus. The mass was painless, not attached to the skin. There was a deep irregular ulcer 3 by 6 cm. on the buccal mucosa, the base of which extended to the muscle layer and was not indurated.

There was no history of lues. He had mumps at the age of twenty-two with involvement of the testes. He had no children.

Biopsy taken from lesion of the mouth showed adamantinoma. Kline reaction was negative. Blood and urine were normal.

Patient refused surgical treatment. A course of deep roentgen therapy was given consisting of 2,400 r to each of two fields (one lateral and one from below upward). This dosage was repeated four months later. No appreciable change was seen on the roentgenogram. The prescribed dose evidently stopped the growth of the tumor.

Case vi (Hospital No. 4159). E. L., a white male, aged eight, was brought to the orthopedic clinic on November 17, 1936, because of a lump on the right jaw which had been present for one and a half months. The growth was slowly increasing in size, was painless and at no time caused fever.

Physical examination revealed a firm, immovable, smooth bone-like mass about 1½ inches in diameter over the angle of the right mandible. No area of tenderness or evidence of inflammation was present. Laboratory examination showed blood and urine to be negative. Roentgenograms revealed a sharply defined defect in the body of the right mandible measuring 3 by 5 cm. in size. The cortex was thin. Several bony bridges traversed the defect forming a multiloculated cyst.

Patient was admitted to the hospital on plastic surgery where excision of the mass was done under local anesthesia. The cystic tumor contained clear fluid within the thin bony cortex. The cavity was curetted and cauterized with phenol and an electrical cautery. A phenol pack was placed in the cavity. A biopsy was sent for microscopic examination. Diagnosis, adamantinoma.

Patient was discharged after fifteen days in the hospital and followed in the out-patient department. On December 30, 1937, one year later, recurrence of a small cyst of the right jaw was noted. Patient was readmitted; surgical removal was again done.

The mass was 1 by 2 inches in size and involved three molar teeth. One month later the cyst was again opened and curetted. Patient was discharged on March 17, 1938.

On June 9, 1938, a recurrence of the cyst of the right mandible was found again. On December 5, 1938, under ether anesthesia the cyst was removed. Roentgen therapy was given consisting of 1,600 r to each field—one lateral and one from below upward—using crossfire method.

Fig. 5. Case v. Polycystic bone defects involving entire left mandible producing a honeycomb appearance.

Patient was last seen in February, 1941. He had no complaints. A roentgenogram revealed normal density of the right mandible.

Case vii (Hospital No. 91141). H. J., a white male, aged fifty-seven, was well until November, 1935, eighteen months prior to his being seen in the out-patient department. Onset of illness began with the eating of an apple, at which time he felt and heard a "popping sound" coming from his jaw on the left. Swelling developed in this area, which progressively enlarged, becoming firm, non-tender, and about 1.5 cm. in diameter. At about the same time a "kernel" was noticed under the left side of the chin. Both of these lesions enlarged rapidly during the five to six months previous to admission and finally

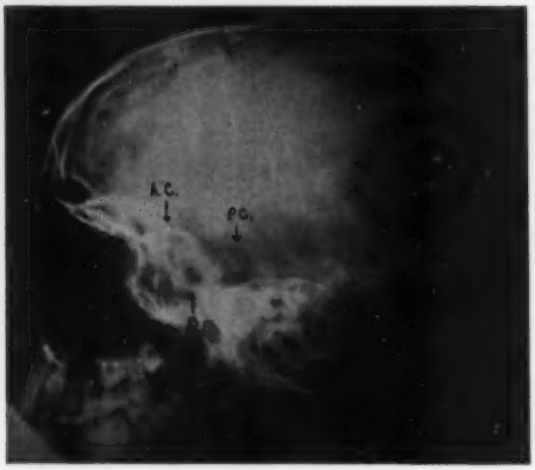

Fig. 6. Case viii. Sella turcica is markedly enlarged in all directions. Posterior clinoids are partly destroyed. *AC*, anterior clinoid process; *PC*, posterior clinoid process; *B*, base of sella turcica.

fused forming a mass the size of an orange over the left side of the jaw.

He had no weight loss, anorexia or inability to do work. Ten months previous to admission three teeth were extracted from the left mandible.

Examination revealed a firm, lobulated mass extending from the tip of the left ear across the side of the face and down to the chin, measuring about 6 by 10 cm. in size. This mass was divided into two parts, one centering over the angle of the jaw and the other beneath the mandible, being apparently an enlarged anterior cervical lymph node. The mass could be seen within the oral cavity. The larger mass over the angle of the jaw was fluctuant, tender, and somewhat crepitant.

Urinalysis was negative. The blood showed a hypochromic, microcytic anemia.

Clinical impression was mixed tumor of the left parotid gland. The patient was transferred to the plastic surgery service and a biopsy was taken under nitrous oxide ether and cyclopropane anesthesia.

The tissue consisted almost entirely of embryonal mesenchymal connective tissue in which there were scattered, immaturely developed gland and tubule-like structures. Lymph spaces were numerous. The epithelium was tall columnar in type. Diagnosis of adamantinoma was made.

For an unexplained reason the patient was not given therapy.

Case viii (Hospital No. 96696). J. D. I., a male, aged eighteen, showing absence of secondary sex characteristics, was admitted to the University of Oklahoma Hospital on May 9, 1938, with chief complaints of headache, blindness of right eye, pains in the back, neck, sides and abdomen with attacks of unexplained nausea and vomiting.

Onset of illness was at the age of twelve years while in the eighth grade at school. At that time he began complaining of headaches starting in the right side of head which had progressively become worse. Blindness of right eye started three years before admission to the hospital. During these six years he had irregular attacks of dizziness, weakness and staggering gait, followed by episodes of questionable unconsciousness lasting two to three days. Nausea and vomiting started about one week before hospitalization.

Neurological examination was made with a tentative diagnosis of expanding intracranial lesion. Roentgenograms were made of the skull, sella, hands and wrists, which showed the sella turcica to be markedly enlarged, the floor being thin, displaced downward and partly destroyed. The posterior clinoids were destroyed, also some destruction was noted at the anterior clinoids. Development of the bones of both hands and wrists was normal.

On May 31, 1938, a right frontal craniotomy and a right prefrontal lobectomy were done to expose the pituitary region. There was marked intracranial pressure. A large suprasellar tumor containing numerous cystic cavities approximately 4 ounces in volume was found.

Microscopic section revealed brain tissue and tumor. The tumor cells were poorly differentiated, somewhat embryonic appearing, epithelial in type and containing darkly stained nuclei. Stroma was exceedingly scanty. The cells were arranged in compact sheets with long branching strands. There were numerous spaces, some of which were filled with red blood cells. Occasional areas showed calcification. In addition, adjacent portions of connective tissue in the brain showed leukocytic infiltration. Microscopic diagnosis: Embryonal tumor of adenomatous type; adamantinoma.

Laboratory findings: red blood cells 4,490,000; hemoglobin 80 per cent, white blood cells 8,400; neutrophiles 44 per cent, blood Wassermann reaction negative; urinalysis negative; basal metabolism −12.5 per cent.

The patient's immediate condition was not good and continued grave until his death about twenty-four hours later.

SUMMARY

1. Eight cases of adamantinoma have been reported. One occurred primarily in the pituitary body and seven in the jaw. One of these in the latter group developed pulmonary metastasis.

2. Although generally considered as a benign tumor, a review of the literature proves that malignancy and even metastasis may occur.

3. Age incidence is wide, the female sex and the Negro race being most commonly affected.

4. Although adamantinomas may originate from several sources, they can all be traced back to the parent cell, the oral epithelium.

5. Several tumors of the pituitary body and tibia were reported having the exact microscopic appearance of an adamantinoma.

6. Adamantinoma wherever originated is composed of groups of epithelial cells in a stroma of connective tissue. Macroscopically, they are solid or cystic in type.

7. Adamantinoma of the jaw is characterized by its long duration, being a painless, slowly growing, centrally located tumor.

8. On the roentgenogram the lobulated and polycystic apperance of the bone defect is characteristic and serves as a differential diagnostic aid.

9. Review of the literature revealed only fourteen cases with regional or distant metastases. We add our case (Case 1) to this list.

10. Adamantinoma is a meaningless term. Probably adamantin epithelioma would be the proper name, since it would indicate the histogenesis and potential malignancy of these tumors.

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PULMONARY METASTASIS AND PNEUMONITIS FOLLOWING RADIATION THERAPY FOR CANCER OF THE BREAST*

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PULMONARY metastases from cancer of the breast occur in many forms, and most radiologists are familiar with their roentgen manifestations. Farrell,[6] in discussing this subject, classifies pulmonary metastases from cancer of the breast into nodular, miliary, infiltrative, and massive types; Jones and Burr[9] describe nodular and permeative forms and give an explanation for the mechanism of their formation in relation to the blood and lymph streams; Simpson[17] has discussed the mechanism of metastases occurring on the parietal and visceral pleura, and Olsen[14] emphasizes pleural effusion as a manifestation of metastases.

Our interest in this subject has been concerned first, with determining whether irradiation given prior to the formation of metastases will influence the type of shadow that the subsequent metastatic lesions will produce, and second, if infiltrative metastases of the lung from cancer of the breast can be differentiated from chronic irradiation pneumonitis.

From a series of 76 patients, we selected for this investigation 54 cases of cancer of the breast in whom we recognized three essential types of pulmonary metastases:

1. Nodular.
2. Infiltrative.
3. Pleural—with or without effusion.

The distribution of the various types is shown in Table I. The age distribution is shown in Table II.

TABLE I

	Cases
Nodular type	19
Infiltrative type	20
Pleural type	10
Mixed type (showing two types in one patient)	5
TOTAL	54

TABLE II

Age	Nodular Type	Infiltrative Type	Pleural Type	Mixed Type
20–39	4	6	2	2
40–59	10	11	5	1
60–79	4	3	3	2
80–	1	0	0	0
TOTAL	19	20	10	5

The *nodular type* (Fig. 1) is readily recognized. The roentgen appearance is that of varying sized, discrete, circumscribed, dense areas distributed throughout the parenchyma. Although usually bilateral, they may occur on one side only. Occasionally, a single nodule may be the only manifestation of metastasis. The *infiltrative type* (Fig. 2, *A* and *B*) is characterized by closely spaced, coarse, linear shadows starting apparently in the hilar region and progressing toward the periphery of the lung in a fan-shaped fashion. Other features of the infiltrative type, although less constant, include elevation and limitation of movement of the dome of the diaphragm on the affected side, and narrowing of the intercostal spaces resulting in a contracted hemi-

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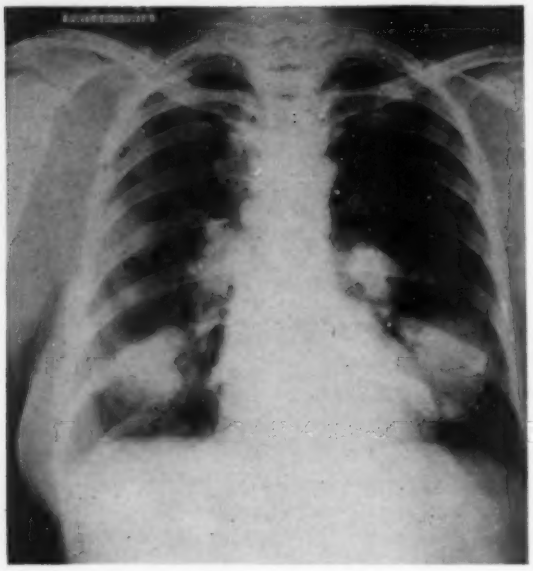

FIG. 1. Nodular metastases on both sides. No roentgen therapy was administered to the chest prior to the appearance of the metastases.

thorax. The mediastinum is usually not shifted. The *pleural type* of metastases (Fig. 3) is found as dense nodules or thickened localized areas on either the parietal or visceral pleura, or on both.

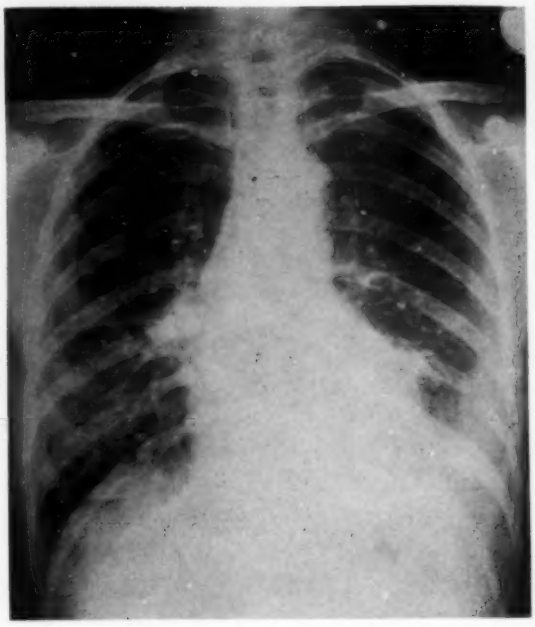

FIG. 3. Pleural metastasis on left, most of which is in a thickened plaque formation. There is also beginning infiltrative change on the right side.

Pleural effusion may obscure the pleural nodules. In order to demonstrate the nodules, it is necessary to withdraw the fluid

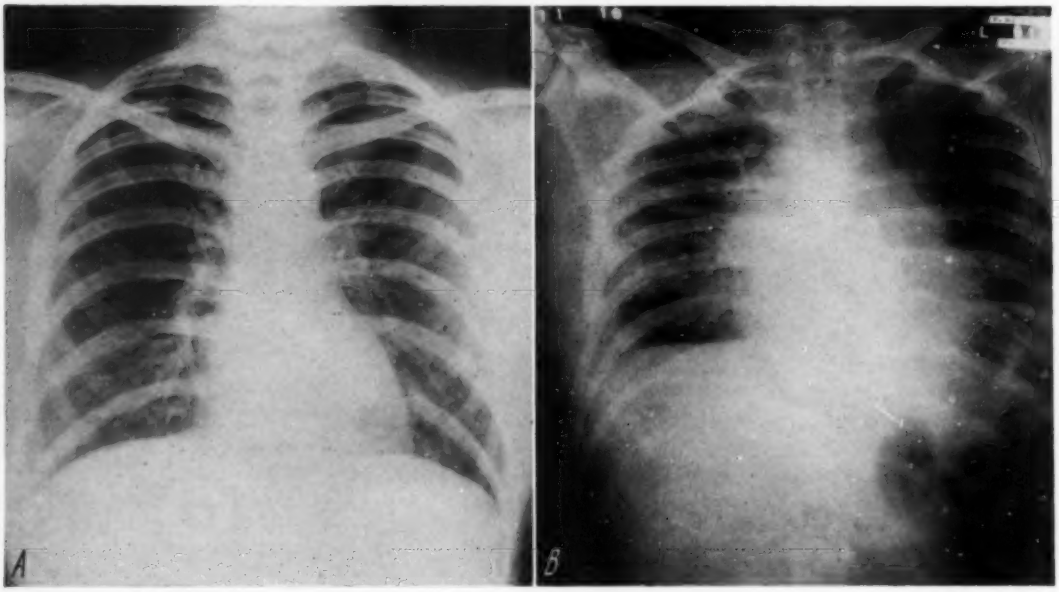

FIG. 2. *A*, control roentgenogram (posteroanterior) negative, taken on October 16, 1936. *B*, same case, taken on November 16, 1937. This anteroposterior view shows infiltrative metastasis on the right side after moderate roentgen therapy had been administered over the right side of the chest.

and introduce air into the pleural cavity before making roentgenograms of the chest (Fig. 4).

The technique of irradiation for cancer of the breast has varied considerably in this clinic over the past thirty-five years, and this variation has been described by Pendergrass and Hodes.[15] The essential techniques are listed in Table III.

The therapy was given in the form of periodic courses, and each field received the equivalent of approximately 2 skin erythema doses during each course. The interval between courses varied from six weeks to seven months. The relative amounts of irradiation to the lungs have been divided into the following categories, taking into account the various factors noted in Table III:

None: No treatment to the chest.
Light: Two courses of Technique I.
Moderate: Four courses of Technique I.
Heavy: Three or more courses of Technique II or III. Two or more courses of Technique IV.

In any case where the technique of irradiation varied from the standards described above, a fairly accurate estimate could be derived.

Fig. 4. Roentgenogram made with patient lying on the left side. The fluid has been removed from the right chest, and air has been introduced in order to show the pleural metastasis.

Table III

Technique	Kilovolts	Milliamperes	Distance, cm.	Filtration	Size of Field
I	130	5	24	3.0 mm. Al	10×10 cm.
II	135	5	30–40	4.0 mm. Al or 0.25 mm. Cu	15×15 cm. 17×17 cm. 20×20 cm.
III	160	15	50	0.5 mm. Cu 2.0 mm. Al	17×17 cm.
IV	200	14–20	50	0.5 mm. Cu 1.0 mm. Al	15×15 cm.

Table IV

Type	None	Light	Moderate	Heavy	Total
Nodular	13	4	2	0	19
Infiltrative	2	3	6	9	20
Pleural	2	3	2	3	10
Total	17	10	10	12	49*

* Five cases were not included because they had more than one type of metastasis (see Table I).

The relation of the degree of premetastatic irradiation to the types of metastases is shown in Table IV. From these figures, it would seem that increasing amounts of premetastatic irradiation to the lung fields are associated with the infiltrative type of metastases (15 cases), while the nodular type usually occurs where little or no radiation has been directed to the lung fields (17 cases). The pleural type of metastases appears equally after all degrees of irradiation.

Although no definite rule may be drawn from these figures, we are able to state that there is a definite tendency to this relationship of premetastatic irradiation and the type of pulmonary metastasis.

Table V

Case	Type of Metastasis	Degree of Pulmonary Irradiation
I	R. Nodular	None
	L. Pleural	None
II*	R. Pleural	Moderate
	L. Nodular	Heavy
III	R. Infiltrative—with few nodules	Moderate
	L. Nodular	None
IV	R. Infiltrative	None
	L. Pleural	None
V	L. Pleural—with few nodules	Moderate

* These metastases occurred three years after pulmonary irradiation.

There were 5 cases showing mixed forms of metastases. In some instances there were different amounts of radiation given to each side of the chest, while in 2 cases no radiation was given over the lung fields. There was 1 case where nodular metastases occurred after heavy irradiation, but these metastases were first noted three years after the treatment had been given. The distribution of the mixed metastases and the amounts of radiation to each side of the chest are shown in Table v.

The possible relation between the histopathologic type of the primary breast cancer and the type of metastasis was considered, but the data in Table VI show a fairly even distribution of the histopathologic type.

Although the diagnosis of pulmonary metastasis is fairly easy in the nodular and pleural forms, the infiltrative type of metastasis offers more difficulty since it may be confused with pneumonitis following irradiation. There were 20 patients who showed lung changes on either one or both sides that were interpreted as infiltrative types of metastases. Although we do not have postmortem confirmation of the roentgen diagnosis, the clinical picture and the relatively short time of survival of the patients after the observation of the pulmonary changes make one suspect that the pathologic condition in the lung was due to metastases.

Our observations on irradiation pneumonitis are essentially the same as those described by other authors.[2,5,7,12,18] These include elevation of the dome of the diaphragm on the affected side, retraction of the mediastinal structures, contracted hemithorax, and changes in the lung fields (Fig. 5, *A* and *B*).

In at least 3 cases with pneumonitis following irradiation we have observed emphysematous bleb formation on the affected side (Fig. 5, *C*). The bleb formation would appear to be secondary to the extensive lung changes in patients who have lived for years following treatment. Warren and Gates[19] have recently called attention to the occurrence of partial, irregular atelectasis and emphysema in irradiation pneu-

Table VI

Type of Metastasis	Adeno-carcinoma	Scirrhous Carcinoma	Carcinoma Simplex	Medullary Carcinoma	Epidermoid Carcinoma	Paget's Disease	Undetermined
Nodular	6	1	2	0	0	0	10
Infiltrative	6	4	1	3	0	1	5
Pleural	2	1	1	2	1	0	3
Mixed	3	0	0	0	0	0	2
Total	17	6	4	5	1	1	20

monitis. These findings are supported by both animal experiments and pathologic observations in the human irradiated lung. In the conventional roentgenograms of the chest and those made with the aid of a Potter-Bucky diaphragm, the emphysematous blebs were noted as rounded radiolucent areas within and along the periphery of the lung density. In 1 patient, the blebs along the periphery were best shown after the occurrence of a pneumothorax (Fig. 5, *C*). The blebs may be small or quite large and cause the mediastinum to return toward its normal position.

The illustrations of representative roentgenograms of the patient shown in Figure 5, *A*, *B*, and *C*, bring out another important consideration. In the patient (Fig. 5, *C*) who developed the pneumothorax after a possible rupture of one of the blebs, we were unable to demonstrate any unusual changes in either the parietal or visceral pleura. There were no pleural adhesions and the lung collapsed readily from the thoracic wall. The pathologic condition occurring in the lung following heavy irradiation has been commonly referred to as "pleuropneumonitis." Such terminology

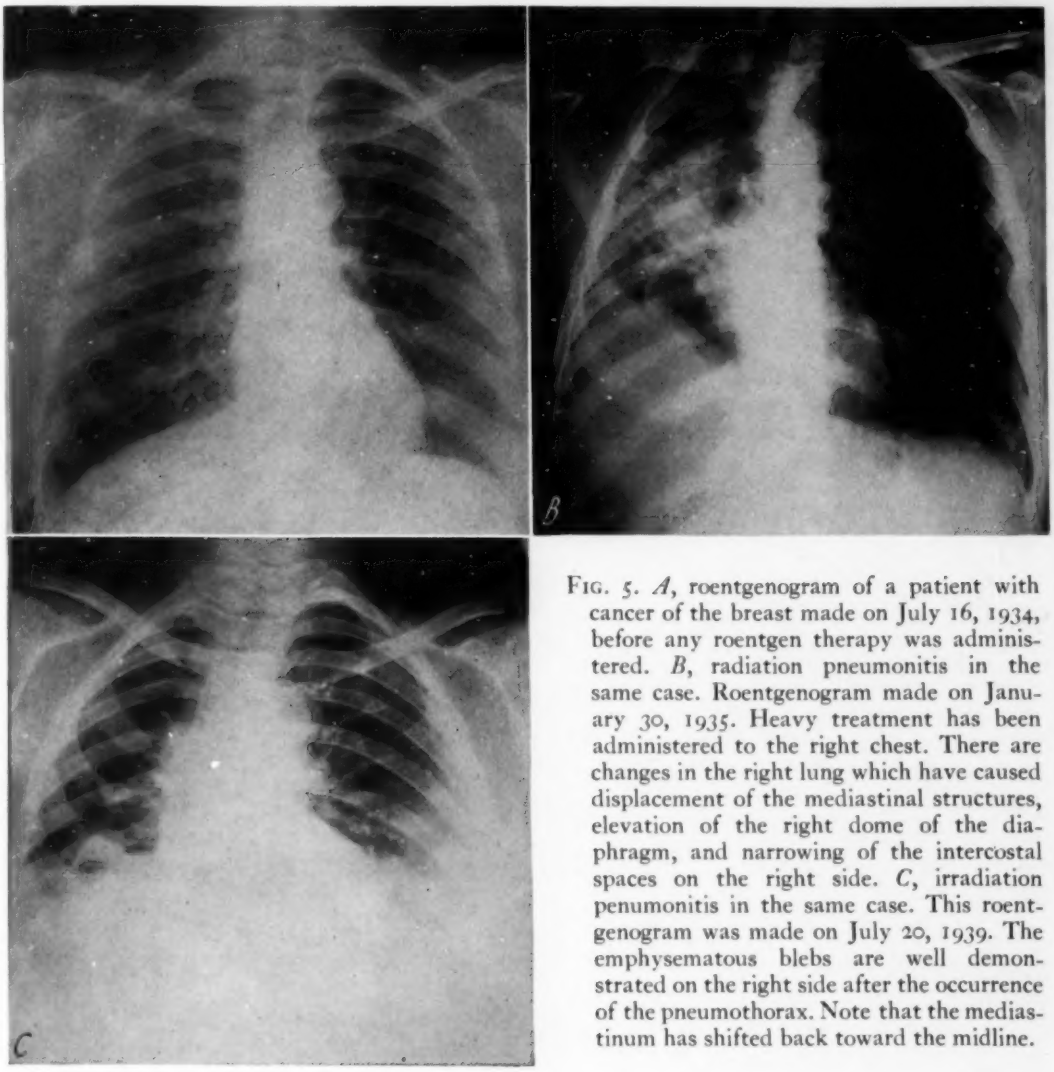

Fig. 5. *A*, roentgenogram of a patient with cancer of the breast made on July 16, 1934, before any roentgen therapy was administered. *B*, radiation pneumonitis in the same case. Roentgenogram made on January 30, 1935. Heavy treatment has been administered to the right chest. There are changes in the right lung which have caused displacement of the mediastinal structures, elevation of the right dome of the diaphragm, and narrowing of the intercostal spaces on the right side. *C*, irradiation penumonitis in the same case. This roentgenogram was made on July 20, 1939. The emphysematous blebs are well demonstrated on the right side after the occurrence of the pneumothorax. Note that the mediastinum has shifted back toward the midline.

would seem to indicate that the process involves the pleura and the lung. Warren and Gates[19] have demonstrated that "radiation pneumonitis is not clearly associated with pleural reaction other than edema and congestion." Their choice of the term "radiation pneumonitis" seems to be a more accurate description for the condition which has been referred to as pleuropneumonitis, and our roentgen observations seem to substantiate this choice.

The roentgen manifestations of irradiation pneumonitis are in many instances similar to those found in infiltrative metastases from cancer of the breast, and it may be impossible to differentiate the two conditions in the living patient. When we began our study, we felt that we would be able to present a group of diagnostic criteria upon which one might differentiate between infiltrative metastases and irradiation pneumonitis. Much to our disappoint-

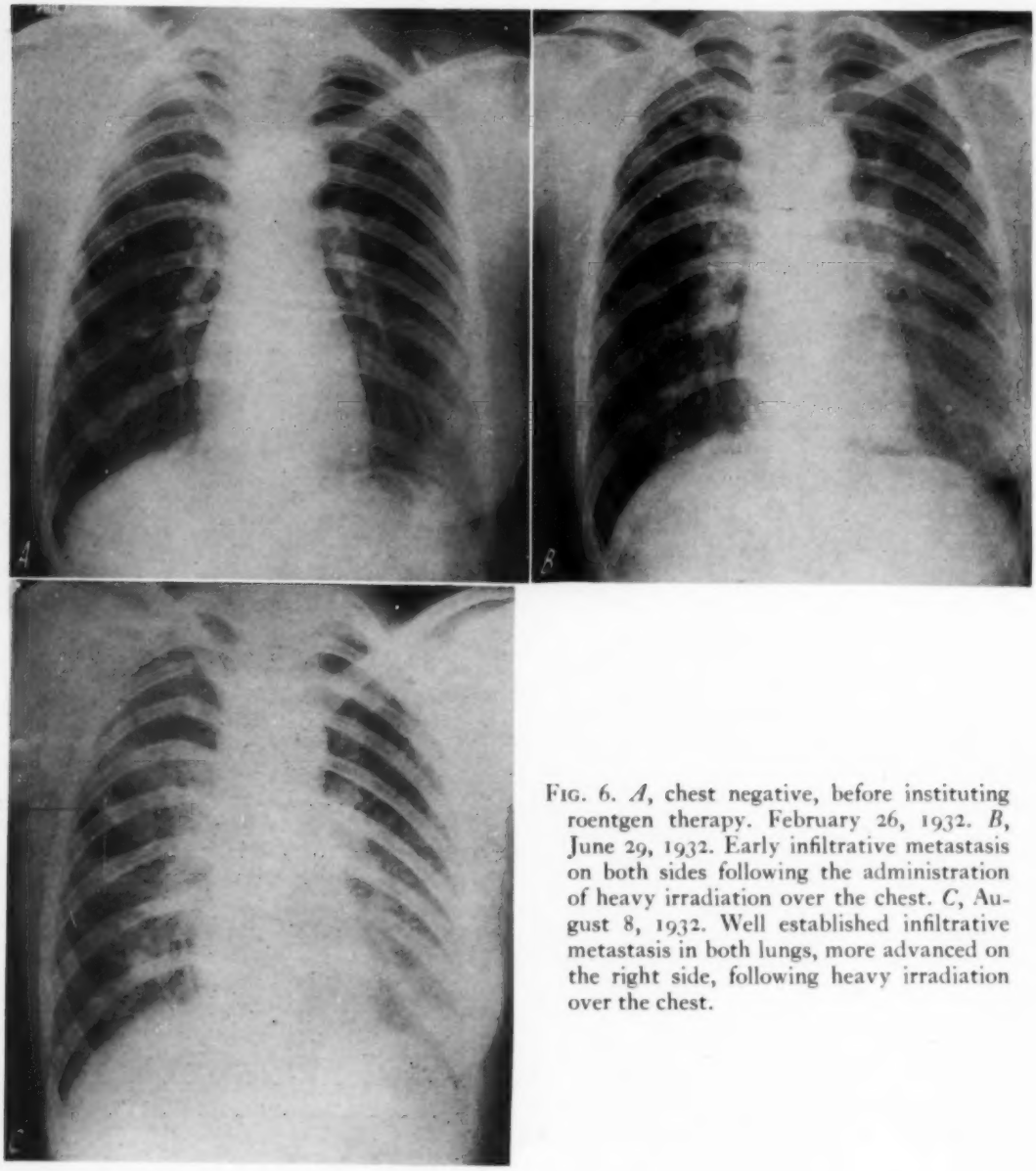

Fig. 6. *A*, chest negative, before instituting roentgen therapy. February 26, 1932. *B*, June 29, 1932. Early infiltrative metastasis on both sides following the administration of heavy irradiation over the chest. *C*, August 8, 1932. Well established infiltrative metastasis in both lungs, more advanced on the right side, following heavy irradiation over the chest.

ment, we learned very soon that such a differentiation could not be made in a number of instances, and in fact, it was necessary for us to exclude from this study 11 cases in whom it was impossible to differentiate between the two conditions.

If one studies the chest frequently during and after irradiation, as advised by McIntosh and Spitz,[12] we believe that the correct diagnosis is more likely to be made. The early changes in the lungs following irradiation are diffuse. As the acute manifestation of irradiation pneumonitis passes into the chronic phase, the diffuse haze is replaced by coarser and less homogeneous shadows. The infiltrative metastases usually appear first in the hilar region and then spread gradually into the parenchyma in a fan-shaped fashion to involve a considerable portion of the lung or a part of it. One cannot emphasize too much the importance of obtaining a roentgenogram of the chest before instituting roentgen therapy, in order to compare it with subsequent studies of the chest (Fig. 6, *A*, *B* and *C*). We have never observed bleb formation in patients with infiltrative metastases and this may represent an important differential diagnostic sign. This sign, however, is not pathognomonic because metastatic nodes in

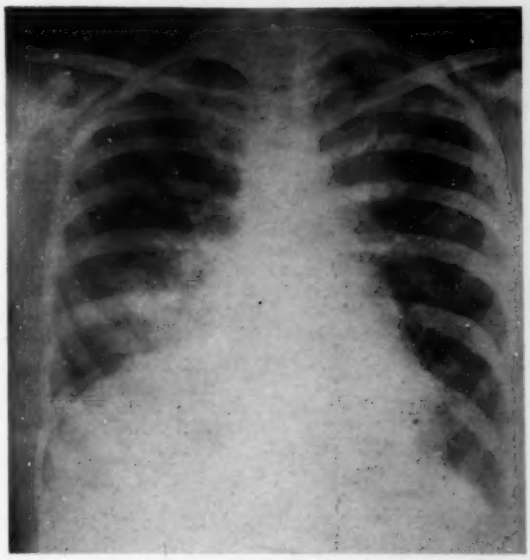

Fig. 7. Infiltrative metastasis on the right side associated with elevated diaphragm. No roentgen therapy to chest.

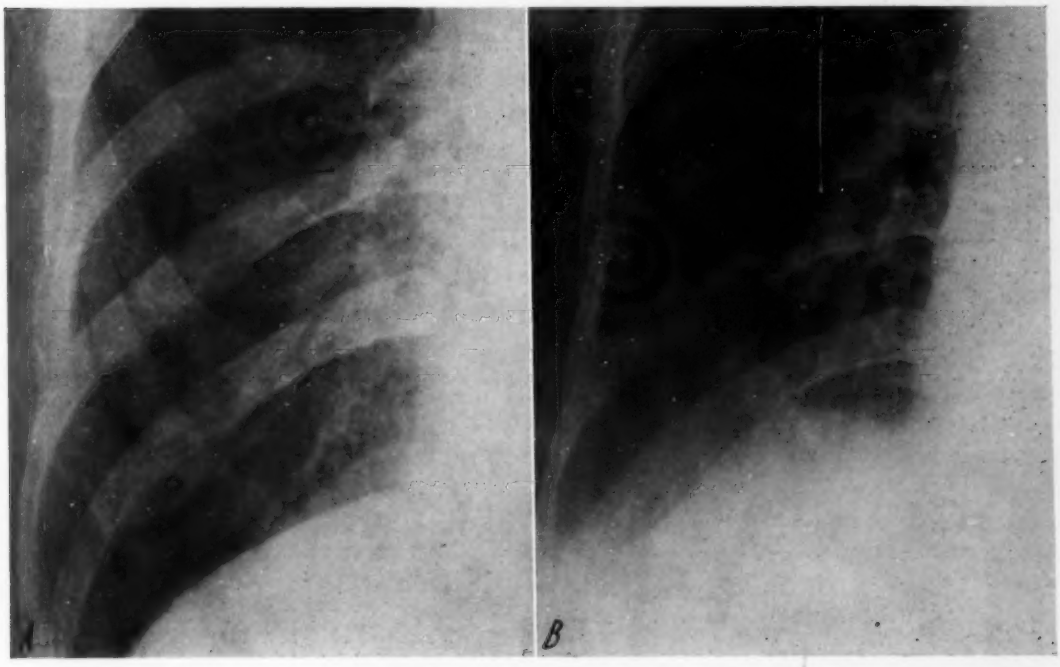

Fig. 8. *A*, June 27, 1932. The right dome of the diaphragm appears normal. *B*, January 10, 1933. The inner third of the dome of the diaphragm is elevated due to restricted movement caused by infiltrative metastasis.

the hilum may compress the bronchi, producing partial atelectasis and emphysema.[18]

Elevation of the dome of the diaphragm on the affected side has been described in irradiation pneumonitis. We have found this change occurring in infiltrative metastases (Fig. 7, 8, *A* and *B*).

We recognize the possibility that infiltrative metastases and irradiation pneumonitis may be present at the same time. In such instances, it would be impossible to make a diagnosis without a postmortem examination.

Clinically, cough was the most frequent symptom in pulmonary metastases. Dyspnea, chest pain, and weakness were also noted, and in that order of frequency. These symptoms are also found in irradiation pneumonitis. Thus, the differential diagnosis on the basis of clinical findings would be difficult.

SUMMARY

Fifty-four cases of pulmonary metastasis from cancer of the breast are presented, demonstrating three essential types of metastases: (1) nodular, (2) infiltrative, and (3) pleural.

The influence of roentgen therapy prior to the development of metastasis is discussed. Nodular types of metastasis occur in those patients in whom there has been little or no irradiation to the lungs, while the infiltrative forms are found more often after relatively heavier doses of roentgen therapy to the lung fields.

Bleb formation is described as a possible additional diagnostic sign in irradiation pneumonitis. The use of the term pleuropneumonitis is questioned. The similarity of infiltrative metastases and irradiation pneumonitis is briefly discussed.*

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* For discussion see page 511.

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FREQUENCY, CLINICAL COURSE AND TREATMENT OF METASTASES FROM CANCER OF THE BREAST*

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THE frequency, clinical course and response to radiotherapy of metastases from cancer of the breast are best studied in patients whose histories are known from the time of discovery of the tumor to the time of death. Patients alive when they are investigated, or those dying accidentally or from intercurrent disease, illustrate only single chapters in the life history of the cancer and do not give a true picture of the disease as a whole. The data to be presented are based on patients with cancer of the breast who died while on the Radiotherapeutic and Surgical Services of the Montefiore Hospital for Chronic Diseases, New York City. To simplify this discussion, the material has been divided according to the anatomical sites of involvement as follows: (1) skin; (2) regional lymph nodes; (3) skeleton; (4) lungs, pleura and mediastinal lymph nodes; (5) abdominal viscera, and (6) central nervous system.

INVOLVEMENT OF THE SKIN

The material at the Montefiore Hospital was not considered suitable for an investigation of the frequency of involvement of the skin. However, through the courtesy of Drs. Stout and Haagenson, we have the figures of such a study recently made at the Presbyterian Hospital in New York City. They found that in a series of 641 patients, 160 (25 per cent) showed local recurrence of the disease after radical mastectomy. These patients did not have any roentgen therapy to the operative field.

The cutaneous lesions observed in mammary cancer arise in the following ways: (1) by direct invasion from the adjacent primary tumor; (2) by lymphatic emboli; (3) by lymphatic permeation; (4) by emboli from the blood stream. The last route is uncommon.

Direct Invasion of the Skin by Subjacent Tumor. The earliest signs of such involvement may be manifested by the palpation of a small infiltrate, by puckering of the skin, or by localized patches of reddening with thickening. Later stages are bulging, nodulation of the skin in the involved region and finally ulceration.

Invasion by Way of the Lymphatics. This may take one of several forms: infiltration of the skin by lymphatic permeation without external manifestation; isolated nodes or groups of nodules, and cancer en cuirasse. Nodular infiltrations are the most frequent. The common site is the operated field but they may also be seen over the entire trunk, in the scalp, face, arms or even over the lower abdomen. Isolated nodules will occasionally stay localized and grow very slowly. Diffuse lesions have a tendency to rapid spread with the appearance of new groups of nodules. Cancer en cuirasse is produced by extensive cancerous thickening of the skin and subcutaneous tissue, as well as reactive fibrosis. The typical cases show woody infiltration of the skin, as well as areas of ulceration, and reddish and brownish discoloration so that the acute spread has an inflammatory appearance. The arm may also be involved, with resulting pain and massive edema due to pressure and to infiltration of lymphatics, blood vessels and nerves.

Radiotherapy. The response of cutaneous lesions to radiotherapy is dependent upon the type of invasion, and is best discussed under the two main headings of diffuse and of localized discrete involvement.

Diffuse Skin Involvement. This consists of extensive skin infiltration by crops of nodules, as well as diffuse invasion of the deeper layers below the skin, as seen in inflammatory cancer and in cancer en

* Presented at the Twenty-seventh Annual Meeting, American Radium Society, Atlantic City, N. J., June 8–9, 1942.

cuirasse. The treatment of these lesions is difficult and frequently fruitless. Although growth has been slowed, it is usually not possible to control such lesions. The extensive involvement and the rapidity of its spread, even while one area is being treated, explain the poor results usually obtained.

Localized Lesions. These lesions are mainly isolated nodules, or nodules in small groups, arising in the operative field. They are characterized by slow growth and a tendency to remain localized.

These infiltrations, if confined to a small area, may be treated either by irradiation or surgery. Radiotherapy is preferable because it is less likely to be followed by further recurrences. The alternative, surgery, has the following clinical complication, that it is difficult to estimate the outermost extent of the lesion or its depth, with the result that the area of invasion is incised and recurrences follow.

For this group, we use roentgen therapy generated at low or medium voltage and lightly filtered, applied to a wide field including the lesions. The average single dose for small fields is 300 to 500 roentgens, giving 1,500 r weekly and a total dosage of 3,000 to 5,000 r. If nodules appear at other sites, a similar course is followed. Single doses for large areas are somewhat smaller, the average dose being 250 r and the total dose about 3,000 r. Occasionally, the dosage has been higher than that mentioned above. The higher dosage is used if the skin shows little reaction and the nodules have not disappeared altogether. Bulky masses are treated with 200 kv., divided dose technique, over two or more fields, cross firing tangentially to avoid the deeper portions of the lung. If the lesion occurs close to the sternal border, treatment is also directed to the mediastinum. Experience has shown this to be frequently involved in such instances. In the presence of ulceration or impending breakdown in these lesions, the initial dosage should be small, in order not to induce further necrosis. When the lesions appear clean, the heavier irradiation is given in the manner already noted. Where necrosis has occurred, infection can be controlled by the local application of agents that absorb necrotic tissue and disinfect the field. Among those which have proved useful is zinc perioxide paste. We have also found allantoin ointment to be effective and more recently, the local application of sulfathiazole ointment.

METASTASES TO REGIONAL LYMPH NODES

Axilla. The presence of a cancerous infiltration in the operated axilla shortly following operation is interpreted as (1) that the disease originally was too deep seated for complete extirpation or (2) that the operative procedure had not been sufficiently thorough. The possibility exists, however, that such an infiltrate is inflammatory. If so, the differential diagnosis from a spread of the original disease is difficult. Careful observation for several weeks will usually reveal recession of the mass if it is inflammatory. Continued growth, even if very slow, points to recurring cancer, and when this becomes apparent, radiotherapy is indicated as the treatment of choice.

Lymphedema of the arm on the operated side raises similar questions of differential diagnosis. When it occurs shortly following operation, it may often be an effect of postoperative axillary fibrosis. In this case, it is usually moderate in amount, and associated with an uninvolved axilla. Obvious axillary infiltration by cancer at any stage makes the origin of the lymphedema clear. Lymphedema which occurs at a later date, and with an apparently free axilla and supraclavicular fossa, is another source of diagnostic difficulty. The probable explanation lies either in a deep infiltration which cannot be palpated at this time, or in late irradiation and operative fibrosis, provided the patient had previously received intensive postoperative irradiation. The latter can be considered as an adequate explanation only if the skin and subcutaneous tissues show marked irradiation changes, followed by the early onset of lymphedema. In the absence of irradiation damage, the lymphedema should be observed closely, with frequent careful measurements of the arm and examination

for nodes, infiltrations or recurring disease locally and elsewhere. As soon as the evidence indicates active growth, irradiation should be instituted.

The radiation to the axilla is delivered through anterior, posterior and direct axillary fields, taking in the entire area of disease. Our factors are usually 200 kv., filtration 0.5 to 2 mm. Cu, at a distance of 50 to 80 cm. Divided dose technique, daily treatments, is used, the average dose being 250 to 300 r with backscatter. The treatment is given to the limit of skin tolerance, which generally means 2,000 to 3,000 r per field, when large fields are necessary; and a slightly higher total dosage where the fields are smaller.

Recurrences in the axilla are difficult to control by irradiation, and even more difficult if they are in the apex. In these instances, palliation is about all that can be hoped for.

The foregoing considerations about the technique of treatment apply also to the opposite axilla. If a slowly growing node raises a question of diagnosis, biopsy should be done. Careful examination of the corresponding breast must also be made, as this is frequently involved. Any suspicious thickening present in this breast at this stage is an indication for therapy, biopsy being advised in obscure cases.

Supraclavicular Region. Invasion of the supraclavicular fossa, on the operated side, is seen with great frequency in the later stages of the disease. At this time it is often infiltrating in character and associated with axillary, mediastinal or lung invasion. The cancer may be very deep and difficult to palpate or it may take the form of a diffusely enlarged, stony hard infiltration, without definite borders and with some overlying edema. Occasionally discrete nodes are felt lying deep behind the clavicle in the medial third of the supraclavicular region and with chains of nodes extending superiorly. Nodes may also be situated anterior or posterior to the lower sternocleidomastoid insertion.

If the disease is infiltrating in character, a Horner's syndrome may be present, as well as the severe pain of involvement of the brachial plexus. Pain, however, may be lacking in the early stages, even in the presence of a peripheral neuritis. The complaints then may be numbness or tingling in the fingers or weakness of this extremity. Such involvement is rarely controlled for any length of time by irradiation, no matter how intensively given.

When supraclavicular nodes are seen earlier in the disease, with no evidence of extension elsewhere, they should be regarded as local outposts which may spread to vital areas, if uncontrolled. In these cases, therapy should be given intensively, using a field of irradiation considerably larger than the area of involvement, in order to include the lymphatic drainage into the superior mediastinum. These nodes will frequently disappear following such irradiation.

SKELETAL METASTASES

A painstaking and detailed study of bone involvement, in 168 cases of cancer of the breast, was made by one of us (J. R. F.) in 1931, in collaboration with Dr. Maurice Lenz. Eighty-one cases (48 per cent) had skeletal metastases proved roentgenographically or at autopsy.

Anatomical Distribution of Skeletal Metastases. Among the 81 cases, there were only 13 (16 per cent) that apparently had metastases to the skeleton alone. In the remainder, skeletal invasion was associated with metastases to one or several of the other body systems.

Most of the skeletal metastases were multiple. Of the 81 cases, only 14 showed involvement of a single bone, and even in these it may be questioned whether some other metastasis was not overlooked.

The regional distribution of the metastases was investigated, first as to general distribution (Table I), and second as to the site of the first localization (Table II). The latter study probably gives a truer picture of the predilection of the metastatic process for certain bones.

Of the 45 cases of skeletal metastases

occurring in the pre-terminal stage,* the skeleton was the primary localization in 82 per cent. In only 6 cases did roentgenographic or clinical evidence of other metastases precede skeletal invasion; in 3, these were pulmonary, and in 3, cutaneous metastases. The metastases, however, did not remain localized to the skeleton. In 36 cases (80 per cent), they were complicated by metastases to other parts of the body.

TABLE I

Number of Cases 168

Cases with skeletal metastases 81 - 48%

ANATOMICAL DISTRIBUTION

Localization	No. of Cases	Percent
Pelvis	51	62
Cervical 8		
Spine	48	59
Dorsal 24		
Lumbar 34		
Sacral 23		
Femur	44	54
Ribs	32	39
Skull	29	35
Humerus	22	27
Scapula	13	16
Clavicle	12	14
Tibia	3	3
Sternum	1	1
Radius	1	1
Ulna	1	1
Hands	1	1
Fibula	1	1
Bones of feet	1	1

1. The metastases were generally multiple.

2. Type A. Chiefly osteoclastic.
B. Osteoblastic changes also frequently present.

Clinical Symptomatology. Pain, and less frequently bony tenderness on direct pressure or percussion, is usually the first symptom of invasion of the skeletal system. In 61 of 81 cases, or 75 per cent, attention was drawn to the presence of bone metastases because the patient complained of localized pain. This was usually at the site of metastasis; occasionally, however, it was over the area of distribution of the nerve immediately adjacent to this area. In 9 cases, it was possible to follow the gradual appearance of definite roentgenographic evidence of skeletal metastases in places where the patient had been complaining of pain from one-half to twelve months prior to positive roentgen findings.

Pathological Fractures. Pathological fractures of one or more of the long or flat bones were encountered in 21 cases (26 per cent). Although often a later terminal manifestation, these fractures occur also in the earlier stages of the spread of the disease.

Therapy. The irradiation of skeletal metastases produces results ranging from partial palliation of pain to permanent control of individual lesions. The mode of treatment is determined by the extent of the lesions and by the stage of the disease. When the metastatic foci are numerous, treatment is limited to the sites causing symptoms, or to areas where fracture of the bone seems imminent. When visceral metastases are also present, palliation is the sole therapeutic aim. On the other hand, when the foci are slowly growing and new involvements are few or absent, intensive therapy is indicated in order to achieve a more lasting control. In this type of case, brilliant results have been obtained, enduring for months to years.

TABLE II

FIRST SITE OF INVOLVEMENT AS SUGGESTED BY PAIN AND LATER CONFIRMED ROENTGENOGRAPHICALLY

75 Cases

	Per Cent	No. of Cases
Lumbosacral spine	37	28
Femur	16	12
Pelvis	14	11
Skull	13	10
Dorsal spine	5	4
Ribs	5	4
Humerus	4	3
Scapula	2	2
Clavicle	1	1
Tibia	1	1

The degree of symptom control and the changes noted on roentgenograms, serve

* The term of the life of the patient, from the time of the discovery of the primary tumor to death, was divided into two periods. The last third was designated as terminal in contrast to the earlier two-thirds or pre-terminal.

Fig. 1. *A*, metastasis to the right femur one month following radical mastectomy for cancer of the right breast. *B*, roentgenogram six months following local high voltage roentgen therapy shows almost complete restoration of the normal roentgen appearance of the femur.

as guides in determining the amount of radiotherapy to be given. The stages in the healing of the lesions are in the order stated: relief of pain, lack of increase in size of osteolytic areas, diffuse deposition of calcium and, finally, dense calcification and sclerosis. In some cases, where the architecture of the bone has not been too greatly destroyed, a restoration of the normal roentgen appearance occurs. Such examples of advanced healing have required from 3,000 to 7,000 r, total dose, divided over several fields, directed to one site. Relief of pain and partial sclerosis may be accomplished with much smaller total doses, for example 1,000 to 1,500 r. With the healing comes return of function so that incapacitated patients are able to resume normal activity.

In patients with diffuse involvement and rapidly growing lesions, control of symptoms is more difficult. The progressive loss of strength and appetite and the occurrence of new lesions elsewhere in the skeleton are indications that these patients will respond poorly. Careful examination of these individuals often reveals visceral, gland or skin invasion. These new extensions of the disease partially account for the unsatisfactory results.

The usual supposition that pathological fractures do not heal is incorrect. In a patient whose other lesions have responded to radiotherapy, it is not uncommon to see fractures mend after protracted irradiation. Such cases are helped by immobilization in a plaster cast containing one or two large windows through which the radiation can be delivered.

In treating patients with extensive skeletal metastases, the referring physician or surgeon should bear in mind that therapy is not a matter of a few roentgen-ray exposures. The number of treatments needed to

afford comfort to these patients will depend on the number of sites that are causing pain and symptoms as well as on the response of the individual lesions to the irradiation. Very weak and disabled patients are best hospitalized for the course of therapy, especially so, since very sick individuals can tolerate only limited exposures and often may require a day or two of rest between treatments. At times, the cachexia and severe anemia are indications for blood transfusions or a series of intravenous glucose injections. The last named is given when severe anorexia, nausea or vomiting are persistent features. General medical care and diet are important. The use of iron, liver extract, vitamin B_1, and nicotinic acid is helpful. In cases with extensive bone metastases, a high blood calcium is a common finding due to the mobilization of calcium from the involved bones. To partly replace this loss, patients are given calcium by mouth, 10 grams or more daily, as well as plenty of milk. To relieve pain, various medications, such as salicylates, codeine, morphine, and other analgesics are indicated until the symptoms are thoroughly controlled by irradiation.

Many patients with extensive spinal involvement will obtain relief from a stiff mattress or a fracture board in the bed. Where collapse or impending collapse of the spine is present, as well as for a similar involvement of the femur, the use of a plaster cast or brace is often helpful. Patients with extensive skeletal destruction may be more comfortable on an air mattress. These measures render the patients more comfortable and help to conserve their well-being until the response from radiotherapy is apparent.

INVOLVEMENT OF LUNGS, PLEURA AND MEDIASTINAL LYMPH NODES

Statistics show no unanimity as to the frequency of intrathoracic metastases in fatal cases of cancer of the breast. Gross, from 423 autopsies, found the pleura involved in 42 per cent, the lungs in 41 per cent, the lungs and pleura in 8.9 per cent, and the bronchial and mediastinal lymph nodes in 4.4 per cent. Handley states that pulmonary metastases are present in only 25 per cent of the cases. More recently, however, Warren and Witham found pulmonary involvement in 58 per cent of their cases and pleural in 35 per cent. In the newest contribution to this subject, by Saphir and Parker, metastases were present in the lungs in 65 per cent and in the pleura in 23 per cent.

We investigated two groups of patients for pulmonary and pleural involvement. The first was primarily a clinical study, with only partial postmortem confirmation, of 168 cases at Montefiore Hospital up to 1930. The other group consisted of 131 postmortem examinations on patients with cancer of the breast who died in Montefiore Hospital during the years 1930–1939, inclusive. In the first group, only 47 per cent were so involved. These figures jumped to 89 per cent for the postmortem series. In only 1 instance was there involvement of the heart without involvement of other intrathoracic structures.

Anatomical Distribution. The regional distribution of the metastases in the postmortem group are recorded in Table III.

TABLE III

Organ	Per Cent	Number
Lungs alone	12	14
Pleura alone	2	2
Mediastinal lymph nodes alone	2	2
Epicardium alone	1	1
Lungs and pleura	34	40
Lungs, pleura and mediastinal lymph nodes	36	42
Lungs and mediastinal lymph nodes	10	12
Pleura and mediastinal lymph nodes	3	4
Heart: Pericardium plus lungs or pleura	15	12
Heart: Myocardium plus lungs or pleura		3
Heart: Epicardium plus lungs or pleura		3

These figures suggest that in patients who die as a result of cancer, extension of the disease to the lungs, pleura and medias-

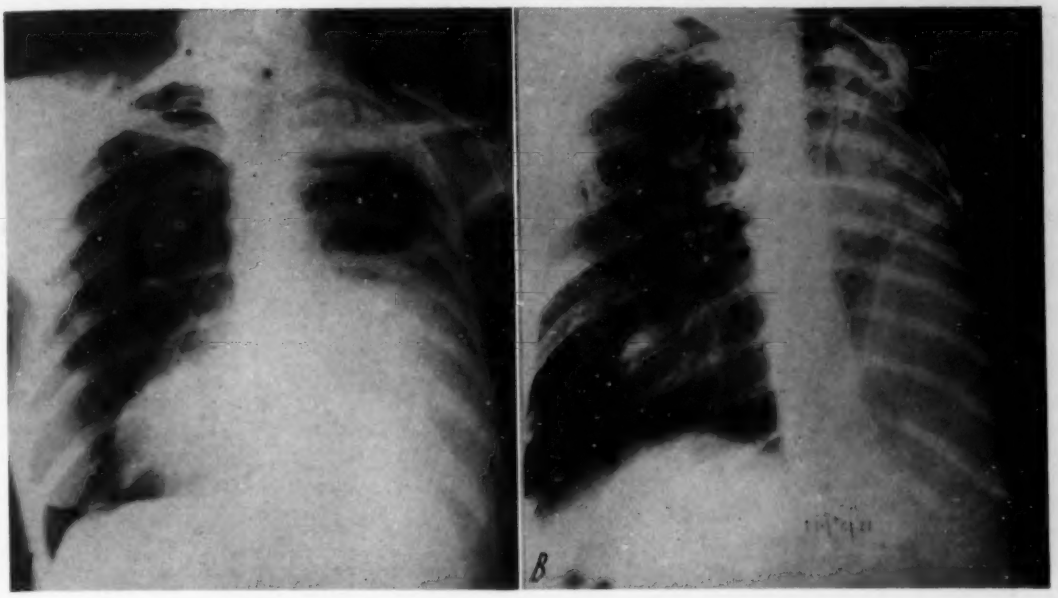

FIG. 2. *A*, massive right pleural effusion six years, four months following radical mastectomy for cancer of the right breast. Diagnosis of adenocarcinoma made from examination of pleural fluid. *B*, roentgenogram six years following a single course of intensive high voltage irradiation to right chest shows post-irradiation changes in right lung and bony thorax. Patient still well and working, with no complaints.

tinal lymph nodes is almost a constant feature. A comparison of the two series studied leads one to the conclusion that intrathoracic metastases are often either quiescent or else grow slowly and are difficult of early demonstration by roentgenograms. Symptoms probably manifest themselves only when parenchymal invasion is widespread, or if localized, when irritation of bronchi, pleura or mediastinal contents occurs.

It is noteworthy that in the postmortem group there were only 2 cases that had intrathoracic metastases alone. In the remaining cases, the pulmonary involvement was associated with metastases to one or several of the body systems, with the skeleton in 66 per cent, with the skin in 33 per cent, and with the abdominal viscera in 87 per cent.

Clinical Symptomatology. Data were sufficient in the first or clinical group to evaluate symptoms and physical signs. In 70 per cent, clinical symptoms called attention to the pulmonary disease, which was then verified by roentgenograms. Cough was the earliest evidence in 30 per cent, dyspnea in 22 per cent, and pain in 13 per cent. Physical signs were the earliest evidence of pulmonary disease in 30 per cent. These usually were dullness, diminished breath sounds and râles. Cough, the most common complaint, is usually due to involvement of the pleura or to pressure from enlarged tracheobronchial lymph nodes. The cough may be incessant, dry and so severe that it induces retching and nausea. When present with chest pain and localized tenderness, it usually indicates an adhesive pleurisy which soon changes to an effusion. If the effusion is extensive, dyspnea is also present. Dyspnea may also accompany extensive mediastinal and parenchymal infiltration. Cough and tachycardia are sometimes associated with paralysis of the left vocal cord and minimal or negative roentgen findings. This symptom is the reresult of mediastinal adenopathy with secondary involvement of the recurrent laryngeal nerve. Temperature may be a clinical feature associated either with the severe pleuritic stage or, more rarely, with

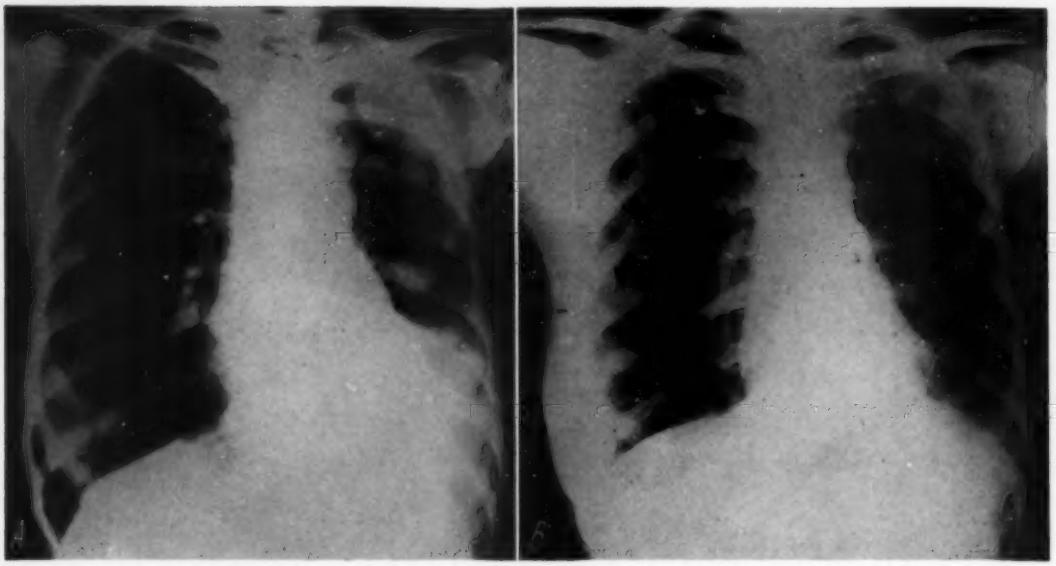

Fig. 3. *A*, metastasis to left lung and pleura three years following radical mastectomy for cancer of left breast. *B*, roentgenogram two months following roentgen sterilization, induced while treating metastases to the pelvic bones. The lungs are clear. Pathological fractures of the fifth and sixth ribs, axillary line, also partially healed. No local treatment to this lung.

tumor necrosis or an associated bronchopneumonia.

Therapy. The literature reveals no agreement on the beneficial effects of radiotherapy in the treatment of pulmonary metastases from mammary cancer. Except for isolated instances, in which unquestioned improvement for long periods has been obtained, the results in the great majority of patients have been poor. Some authors go to the extreme of stating that such treatments do more harm than good. Others feel that radiotherapy is futile because they believe lung metastases are a late manifestation, usually associated with metastases to other systems.

To better evaluate the radiotherapy of intrathoracic metastases, we divided these lesions into three groups—parenchymal, pleural and mediastinal—depending upon which site was most extensively involved, although all these areas were usually invaded.

Parenchymal Lesions. These are, as a rule, of two types: multiple bilateral nodules, and the single metastasis. Multiple lesions are by far the most frequent and appear as small nodules in both lungs. These infiltrations are very resistant to roentgen therapy and little is accomplished by treating such patients. The single conglomerate infiltration is usually fairly large and frequently located in the base of the lung. In some of these cases, growth appears to have been slowed and the patients made more comfortable by irradiation.

Pleural Lesions. Table III indicates that pleural involvement rarely exists alone. In most patients, the accompanying pulmonary or mediastinal growths overshadow the pleural lesion. In these patients, the effects of radiotherapy are also disappointing.

In a small group of patients, the pleural invasion and the symptoms resulting from it predominate. Radiotherapy sometimes gives surprising relief to these individuals. Pleural effusions, dyspnea and palpitation on exertion and cough and cyanosis may disappear or else be markedly improved. High voltage therapy, with doses up to 2,000 to 3,000 r, over two to three fields, by the divided dose technique, has been effective.

Mediastinal Adenopathy. In isolated cases the involvement appears limited to the mediastinum. Radiotherapy may be followed by diminution of the enlarged lymph nodes or by a decrease in the mediastinal infiltration with relief of pressure symptoms when present. Occasionally striking regression in the picture of superior vena cava obstruction is observed.

The generally poor results are partially due to the fact that patients with pulmonary, pleural or mediastinal metastases are usually in poor general condition with metastases also to other organs or systems, especially intra-abdominal, skin and skeletal; and partially due to the fact that the lesions themselves are so widespread and often radioresistant.

The histopathological type of growth and the amount of irradiation given has had very little influence on the final results. Symptoms have been exaggerated in some cases when the dosages were high. In our experience, the patients who did well had metastases to other systems that also responded to the irradiation. It is possible that some natural variation in the course of the disease in these patients may have been responsible for the favorable results.

In the control of the respiratory symptoms, of which cough is the most important, recourse is had mainly to narcotics. When codeine is ineffective, as happens in the cases with mechanical pressure on the trachea and bronchi, the use of morphine or dilaudid becomes necessary. The therapeutic effects of these drugs is enhanced when given in conjunction with the barbiturate sedatives. In the presence of large effusions, tapping is of distinct value in relieving dyspnea and palpitation.

INTRA-ABDOMINAL METASTASES

The 131 autopsies, referred to in the section on pulmonary metastases, were investigated for visceral metastases. The findings are given in Table IV.

Ascites was present in 12 cases (9 per cent). The incidence of visceral metastases in our group is much greater than in similar reports in the earlier literature. Gross, from 423 autopsies, found the liver involved in 48.6 per cent, the ovary in 8 per cent, the kidneys in 5.7 per cent, the retroperitoneal lymph nodes in 5.4 per cent, and the uterus in 5.2 per cent. In 2,534 cases of mammary cancer, collected from Gross, Colwell, Paget, Handley, Gould and Török, the liver was involved in 928, or 36.6 per cent (Ewing). Warren and Witham, however, in 1933 reported liver metastases in 54 per cent, the adrenals in 31 per cent and the ovaries in 9 per cent. In the most recent series, Saphir and Parker found the liver involved in 56 per cent, the adrenals in 44 per cent, the spleen in 23 per cent and the ovaries in 16 per cent. These figures more closely approach our findings.

TABLE IV

Organ		Per Cent	Number of Cases
Liver		65	85
Adrenals		39	51
Ovary		21	28
Spleen		18	24
Kidney		15	20
Pancreas		12	16
Uterus		7	10
Stomach		5	7
Intestines		3	4
Gallbladder		2	3
Vagina		1	2
Urinary Bladder		1	2
Esophagus		0.7	1
Ureters		0.7	1
Peritoneum		10	14
Mesentery		3	5
Omentum		3	4
Lymph nodes	Para-aortic	11	15
	Periportal	6	8
	Abdominal	3	5
	Pancreatic	3	4
	Pelvic	2	3
	Retroperitoneal	2	3
	Mesenteric	2	3
	Perihepatic	1	2
	Omental	0.7	1

Clinical Symptomatology. The symptoms of abdominal involvement are not as clear cut as those of skeletal and intrathoracic metastases. In these patients, in addition

to positive intra-abdominal lymph nodes, there is, as a rule, involvement of multiple organs: primarily the liver, adrenals, ovary spleen and kidney (Table IV). Symptoms from more than one structure may give a confusing picture.

Pain. Pain may be of three types: abdominal, lumbar and sacral.

Lumbar and Sacral Pain. Pain due to bone involvement has already been discussed in the section on skeletal metastases. If the spine and pelvis are not involved, it is likely that one is dealing with metastases to the para-aortic or mesenteric nodes.

Abdominal Pain. Early, this pain may be mild, but gradually it becomes more severe. It is usually localized to the upper abdomen but may be shifting in character. Occasionally, it may be related to meals and suggests the presence of a gastric or duodenal ulcer, or even a primary gastric cancer.

Gastrointestinal Complaints. Liver metastases and metastatic masses in the upper abdomen may give rise to a sense of fullness after eating, even if the amount of food ingested is small, and may cause gaseous or acid eructations, nausea and vomiting. When ascites is present or when the involved organs, as for example the liver, have increased greatly in size, there may be accompanying constipation; less often, diarrhea, progressive enlargement of the abdomen, and abdominal discomfort.

Weakness, Cachexia and Loss of Weight. These are usually marked if intra-abdominal involvement is present. Partly, this may be due to the inability of the patients to retain food, to toxic absorption from broken down tumor, and to metastases to the adrenal glands.

Physical Signs. These may be lacking early, or when the involvement is slight. The most common signs are a sense of resistance and tenderness in the area of involvement. Occasionally, masses may be palpated. The liver, which is the most frequent organ invaded, may be enlarged, firm or irregular. The presence of metastases to the ovary and uterus is sometimes found by vaginal examination.

Therapy. The response of intra-abdominal metastases to irradiation is poor. As noted in Table IV, the metastases are primarily to the viscera. Only rarely are the lesions limited to one organ. Patients with such metastases are generally in poor condition and do not tolerate irradiation well. The unsatisfactory results are therefore understandable. In our experience, we have never seen such metastases disappear. We have, in isolated instances, been able to relieve right upper quadrant pain when the liver has been involved. Relief of pain has also occasionally followed irradiation of other sites, most frequently when due to invasion of the retroperitoneal lymph nodes. Intra-abdominal masses, especially when in the omentum, have diminished in size but have not completely disappeared.

METASTASES TO THE CENTRAL NERVOUS SYSTEM

The literature contains few reports of metastases to the central nervous system from cancer of the breast. Török and Wittelshöfer, from 366 autopsies, found the nervous system involved in 11 per cent. The cerebrum was involved in 6 per cent, the cerebellum in 2.7 per cent, the dura mater in 6.8 per cent and the pia mater in 0.8 per cent. Gross, from 423 autopsies, found the brain involved in 9.4 per cent, the dura mater in 5.9 per cent and the spinal cord in 0.2 per cent.

The protocols of 369 patients were investigated for metastases to the central nervous system. In many instances, clinical differentiation between extension with compression and metastases in the central nervous system itself was difficult if not impossible. Only 40 of the 89 cases with cerebral and spinal cord symptoms were examined postmortem; therefore, our figures as to the frequency of metastases to the central nervous system are not quite accurate. Since metastatic growths in the brain and spinal cord may be symptomless,

there must have been cases with such involvement that were overlooked in this series. Signs pointing to involvement of the central nervous system occurred in 89 cases (24 per cent) of the 369 investigated.

Distribution. Seventy-three cases (20 per cent) showed neurologic evidence of brain involvement. Of these, 45 cases (61 per cent) also showed metastases in roentgenograms of the skull. Thirty-nine intracranial examinations were done, with the brain or meninges positive in 37. This high percentage was due to the special efforts made to obtain complete autopsies in patients with cerebral symptoms. Signs in the cases without postmortem examinations, and findings in those cases where the brain was examined, proved the growths to be more frequently multiple than single. The lesions were most common in the cerebrum and meninges, and occasionally the involvement was confined to one of these sites. In 7 cases, a direct extension from a metastasis in the calvarium could be demonstrated. The postmortem examinations also showed, in 4 instances, involvement of the pituitary gland. In 2 of these cases, the metastasis was limited to the pituitary; the other 2 cases also had multiple intracranial lesions. Metastasis was uncommon to the pineal gland. In the 2 patients where it was observed, one was associated with extensive intracranial involvement, and the other with a lesion in the pituitary gland. The exact intracranial localizations, as determined from the autopsies, are shown in Table v.

Clinical Symptomatology.

Symptomatically the cases can be divided into three groups:

A. Those showing signs of gradually increasing intracranial pressure (9 cases).

B. Those with signs of increasing intracranial pressure and localizing neurologic signs of cerebral, cerebellar and brain stem involvement (30 cases).

C. Those showing neurologic signs of cerebral, cerebellar and brain stem invasion without increased intracranial pressure (29 cases).

In the majority of cases, the brain involvement occurred during the terminal stages of the disease. Five patients, who presented cerebral metastases at the postmortem examination, had been asymptomatic. The pituitary metastases were also occasionally silent. When symptoms were present, they were typical of diabetes insipidus. The longest survival period, after the appearance of cerebral involvement, was thirty-two months; the shortest, a few days.

TABLE V

Localization	No. of Cases
Cerebrum	23 (in 7 only site)
Meninges	22 (in 9 only site)
Cerebellum	6 (in 1 only site)
Pituitary gland	4 (in 2 only site)
Brain stem	2
Pineal gland	2

Spinal Cord Involvement. Twenty-eight cases (7.5 per cent) gave neurologic evidence of cord involvement. In most instances, the cord symptoms were the result of compression by a metastatic focus in the corresponding vertebra. Postmortem examination, however, in 29 cases revealed 6 instances of invasion of the cord or meninges. In 4 cases, the dura was invaded (2 by extension), and in 2 cases the cord was positive (1 by extension). Three cases showed cord compression but no involvement of the cord or meninges.

As in the case of the cerebral group, spinal involvement usually occurred during the terminal stages of the disease. The longest survival period, after the appearance of spinal cord symptoms, was thirty-one months; the shortest, a few days.

Therapy. As in metastases in other parts of the body, treatment given to advanced

lesions of the central system, or in the presence of involvement elsewhere, is palliative. Relief is usually sought for symptoms such as severe headaches, dizzinesss, spinal pain, of severe pain along nerve distributions. The neurological status will indicate what areas should be intensively irradiated. In some cases, symptoms of increased intracranial pressure, headaches, dizziness, etc., have receded; in others, there has been disappearance of disorientation, delusions, and cranial nerve involvement. This improvement, in a few instances, has lasted as long as two years. Usually, the results are less striking.

Similarly, in the case of the spinal cord, symptoms due to pressure or infiltration of the dura or cord, have become less severe with therapy, to the extent that some cases with paresis of the extremities have recovered function. When the invasion of the cord or the collapse of the overlying spine has produced permanent cord damage, these results are not obtained but further extension of the disease may be arrested. When the findings on examination suggest the possibility of a good result, treatment should be intensive, since larger dosage has been necessary in the cases showing any recession of symptoms and lesions.

CASTRATION AND METASTASES

The effect of oöphorectomy on breast cancer was first observed by Beatson in 1896. He noted regression of the breast cancer and the regional lymph nodes following this procedure. He attributed the course of the cancer in the young to abnormal function of the ovaries, and felt that oöphorectomy in cases of mammary cancer should be confined to menstruating women past forty. He saw no effect on distant metastases. Although Beatson gave historical importance to the subject, the failure of others to corroborate these findings caused his observations to be neglected.

Recently, renewed interest has arisen, because of the observation of the effects on pelvic and distant metastases, in cases treated over the pelvis and, coincidentally, castrated. Many clinical and experimental considerations have given support to this procedure. Briefly these observations are: (1) the involution of the glandular breast elements after menopause; (2) the marked changes in the breast seen in the premenstrual and in the lactating periods; (3) the more fulminating course of breast cancer in young menstruating women; (4) the effect of pregnancy on the course of mammary cancer, and (5) on the experimental side, the demonstration that estrogenic substances affect not only the genital tract but also the breasts, to the point of producing (at least in animals) adenoma and even cancer. Today, the occurrence of cancer of the breast is considered to depend more on such hormonal stimuli than on single trauma or factors like lactation.

The emphasis in the recent literature, unlike the earlier idea of Beatson, is the effect of castration on metastatic lesions, especially to bone. Here there has been observed striking recalcification and sclerosis of the lesions, together with disappearance of pain. These findings are present not only locally in the pelvic bones, but also in distant skeletal metastases. The improvement is, at times, almost miraculous and appears to have prolonged life in these patients. In some instances, if pulmonary or pleural involvement is also present, recession of these lesions take place. Even lesions in the involved breast and in the skin may sometimes be noted to partially recede. No changes have been noted in abdominal metastases.

Since the procedure is so simple, all patients with metastases, who have not reached the menopause, should receive roentgen castration. It is debatable whether such patients without metastases should be so treated. No proof is yet available that recession takes place with great constancy in the primary growth or that metastases can be prevented or their appearance delayed. The decision is less difficult in the case of women very close to the menopause. In these cases, castration may be under-

taken if the primary tumor is very malignant and metastases are expected.

There is one other consideration. It is not deemed advisable for patients with mammary cancer to go through a pregnancy for five years after operation. If by the addition of such a five year period the patient reaches the climacteric age level, roentgen castration may be also a satisfactory method of preventing conception.

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DISCUSSION OF PAPERS BY DRS. PENDERGRASS AND WHITE, AND FREID AND GOLDBERG

Dr. Harriet C. McIntosh, New York. It has been a great pleasure to hear these two most interesting papers and I am honored to have been asked to discuss them. The first theme developed by Dr. Pendergrass and Dr. White, of the possibility of a relation between premetastatic irradiation of lung and the type of lung metastasis subsequently developing, is interesting and suggestive. Cautiously they refrain from making deductions, but I should be interested to know whether it is their off-the-record

opinion, or speculation, that this premetastatic irradiation tends to inhibit the nodular type of metastasis with no effect on the infiltrative type, or whether it may in some unknown fashion actively pave the way for the development of the infiltrative type. That is, do they think it tends to stop one, or increase the other?

My own hobby and point of reference in discussing all conditions of irradiated lung is the lung tissue dose. It is unreasonable to expect the authors to draw forth complete sets of these, like rabbits from hats, for reviewed material covering many years past. But I tried moving Dr. Pendergrass' chessmen around a little, and have figured roughly that the Technique II, designated as "moderate," really gives very little lung dose, except near the anterior and anterolateral surfaces, while metastasis scatters itself through all the lung. Therefore in Table IV I should be inclined to throw out the "light" and "moderate" types of treatment as probably negligible to the bulk of the lung beneath. The table would then read:

Nodular type	no treatment	19 cases metastasis
	heavy treatment	no cases metastasis
Infiltrative type	no treatment	11 cases metastasis
	heavy treatment	9 cases metastasis

My calculation may be erroneous, on insufficient data, and not acceptable to Drs. Pendergrass and White, but if they are not wrong they tend to increase the presumption that the heavier amounts of lung irradiation had an inhibiting effect on the development of nodular metastasis, with no effect on the infiltrative type. In any event, it is an interesting idea.

It is quite true that the differentiation between infiltrative metastasis and irradiation pneumonitis is sometimes difficult or impossible to make from a single roentgenogram or stereoroentgenograms. With serial roentgenograms differentiation becomes increasingly simple. If there is no time for this, and one must act on a single examination, a computation of lung tissue dose, plus the speed at which it was given, plus the age of the patient, plus the location of pathology in respect to the beams of radiation, will solve the problem for a large proportion of cases. The difficult cases are the Grade IV fibrosis cases, which once established, do not recede much, even on serial roentgenograms, and so readily mask infiltrative metastasis, or vice versa. Where there is time to study the case, the acute stage of an irradiation pneumonitis can be covered diagnostically by as few as four films,—one before treatment, one at four to six weeks after, and one each at three and six months. During this time the developing and receding changes of irradiation pneumonitis on roentgenograms are characteristic, and if no metastasis was demonstrable in the pre-treatment roentgenogram it will not be likely to develop in this period of active irradiation reaction. Afterward, particularly where there was a histopathologically invasive type of tumor or massive axillary disease, I think it worth while to keep on taking roentgenograms every six months, when receding or stationary fibrosis may be readily distinguished from freshly arising and advancing metastasis. In general, the purpose of differentiation is prognosis, not treatment. If the lesion is fibrosis we do not want to treat it, with roentgen irradiation at least, and if it is the infiltrative type of metastasis, treatment is ineffective.

I had the privilege of reading Drs. Freid and Goldberg's original paper, much fuller and more detailed than the version given here today, and I wouldn't have missed a word of it. Then I made careful lists of facts that seemed especially interesting and important that my own experience agreed with or that were new to me. Then I decided that nothing I could say would really add anything to this interestingly written but encyclopedic text, and that the only thing I could do was to draw a few illustrations for it.

Emotionally the subject of metastatic cancer from the breast is a gloomy one in itself, and discouraging to most contributors to literature. On the one hand, we have a multitude of writings in which the chief or sole yardstick is the five year cure, with secondary interest attached to the techniques by which it was achieved, and on the other hand we have articles, such as those by Daland, showing how long the patient can survive with no treatment whatever. Palliative treatment of metastasis and recurrence has usually in the past been considered statistically a no-man's land, and scientifically not very interesting, because its contribution to curability is so limited.

The late famous Dr. Deaver of Philadelphia used to say, "The Lord deliver me from the man with a single case." Nevertheless I am going to venture on a brief recital of two of

these single cases, not only as illustrations to the present text, but because I believe they show why we do palliative irradiation at all, and serve to remind us that after all statistics are people.

A woman aged thirty-seven was admitted with breast tumor and massive axillary involvement. The pathological description was: small anaplastic duct cells; can be ranked as embryonic tumor arising in an undifferentiated area of the breast. The patient had a radical mastectomy six years before, followed by postoperative irradiation. Here is the calendar of events.

January, 1937—metastasis to right eighth rib.
July, 1937—metastasis to pelvic bones and first lumbar vertebra.
October, 1939—metastasis to second thoracic vertebra.
April, 1940—retreatment of first lumbar vertebra for pain. No change seen on roentgenograms.
In 1941—retreatment of right ilium and first lumbar vertebra for pain, though no breaking down seen on roentgenograms.

Since 1935 she has never been free from cancer, but she has been free of pain most of the time. She has actually worked all of the time during these six years.

My second patient had cancer of the left breast in 1930, of the right breast in 1934, both of the same pathological type. Radical mastectomy and postoperative roentgen irradiation with both. In 1936 an infiltrative process developed in her right lung, together with slowly increasing pleural effusion, and with no fever or acute respiratory symptoms at the outset. Pneumonitis was ruled out by roentgen examination preceding this development. The patient was given 2,000 r (in air) each to anterior and posterior chest fields on the right, and being of slight build, received a good depth dose. The process seemed to increase for awhile, then became apparently stationary. She lived until 1941,—eleven years after the first radical operation, seven years after the second, and five years after the start of the lung metastasis. Autopsy showed gross invasion of the mediastinum and various viscera, and in the lungs multiple foci of miliary-like metastasis, locked up in dense, massive fibrosis.

No one ever expected this patient to be cured after the metastasis developed. But she had five years, during most of which time she supported her family by teaching school, and throughout the whole time she brought up a delicate daughter through a difficult phase to a point where the child could better fend for herself.

I take no credit for such cases. You have all had them. But I think it is wholesome to recall them sometimes, both to "brighten up the corner where we are," and to pay our respects to them, as the human and individual source material of such fine papers as the two we have just heard this morning.

Dr. Joseph H. Farrow, New York. The modification of pulmonary metastases is an interesting observation. I have seen very few of the nodular type as compared to the infiltrative type and am inclined to attribute this to the fact that most of the cases of breast cancer which I have observed have at one time or another received some form of irradiation. I would be extremely interested to know more about the possible mechanism of these phenomena.

In regard to the differential diagnosis of pulmonary fibrosis and the infiltrating type of metastases of breast cancer, it certainly offers a great deal of difficulty at times. I think that the finding of emphysematous blebs is a decided contribution. I have not observed it myself, but in the future I shall certainly make use of such an important differential diagnostic point. However, for its full appreciation, I will leave it to the more critical eye of an experienced roentgenologist.

The presentation of Dr. Freid and Dr. Goldberg is of particular interest and a decided contribution to the investigation of the clinical course of mammary cancer and the treatment of its recurrences and metastases. I think the speaker illustrates quite clearly that the radiologist bears a considerable responsibility in the treatment of breast cancer. In all fairness it may be said that he bears perhaps a greater responsibility to the patient than the surgeon who treats only the limited and selected group which is clinically classified as the primary, operable cases.

The successful palliation of the extension of breast cancer to the various anatomical regions by irradiation is dependent primarily on the individualization of cases, the ingenuity of the radiologist and the regenerative capacity of the involved structures to replace tissues and restore function.

Skeletal metastasis has been of particular interest and during the past two years a special clinic under the supervision of Dr. Adair has

been conducted at the Memorial Hospital for the purpose of investigating the treatment of bone metastases from breast cancer.

We have used high voltage roentgen therapy in doses varying from 200 to 600 r for a single dose or in multiple series. It has been surprising to find that pain is relieved as readily by the small doses as by the large ones. Calcification, however, seems to occur more often following a series of small doses totaling 700 to 1,000 r than following the single massive doses which may be given at two or three month intervals. No cases have been observed which could be pronounced as permanent cures.

Other procedures employed have been the production of a hormone imbalance. Most of you are familiar with castration by pelvic irradiation and its gratifying results in a number of premenopausal cases. Just why only one-third of these cases seem to respond is not known. There is some reason to believe that the vascularity of the metastatic lesion may be an important contribution factor.

For example, an inoperable case of mammary cancer of the breast with numerous metastatic skin nodules was treated solely by irradiation castration about two years ago. When first seen, the skin nodules were quite vascular and this was evidenced by rather marked erythema. Following the castration, one of the first signs of clinical regression of these lesions was a decrease in their vascularity. Four months later the nodules could not be palpated and there was a marked reduction in the breast tumor itself. This control seems to have persisted until the present time.

On four occasions during the four month interval, when the skin nodules were observed to be regressing, we removed one at a time by biopsy. In every instance viable and apparently unaltered cancer cells were seen.

In this particular case it would seem that the regression of the nodules was due to a decrease in the vascularity and a subsequent scarring. It is not known whether such a mode of action is applicable to the control of bone metastases by sterilization since no biopsies of such lesions have been obtained. It is strongly suggestive, particularly when one observes the difference in rate of calcification of lesions in the various bones.

There are other methods of producing a hormone imbalance than by mere castration. Time does not permit me to go into detail but I will merely mention the fact that we have used the male sex hormone, testosterone and esterone with no good results. In fact, in none of the cases did we observe an inhibition of the extension of the disease. On the contrary, in several cases in which quite large doses were given, there seemed to be an activation of the process.

In closing, I think you will perhaps be interested to know of a recent case, a case of a male breast cancer with widespread bone metastasis which was treated only in February of this year (1942). This particular case with an ulcerating cancer of the breast was treated solely by a bilateral orchidectomy. In the brief span of only about four months there has been clinical evidence of regression of the primary lesion, and in addition there has been no further extension of the areas of metastases in the bone and no new ones apparently have appeared. It is also of some interest to note that in bones such as the scapula, the lumbar vertebrae and the ribs, there has been an increased density which has been interpreted as a calcification of the lesion.

Dr. George E. Pfahler, Philadelphia. I would like to emphasize the recommendation made by Dr. White that preliminary roentgenograms be made of every case that is brought to us for roentgen therapy or with the diagnosis of cancer whether it is for roentgen therapy or not.

I had a patient with advanced metastatic cancer brought to me for postoperative treatment in which spontaneous fractures were present. That is only an extreme example, but there are many cases in which we find metastases present before any therapy is given.

Now if we make it the rule—and this will be helpful also in that metastatic group—always to make roentgenograms of the head, neck, chest, spine and pelvis of every case of breast cancer before therapy is started, we will have a record with which we can compare any subsequent developments.

I have not set a definite time for making subsequent roentgenograms but if any symptom whatever arises I repeat and sometimes I am surprised to find that the beginning of a metastatic lesion was present in the original roentgenogram and I overlooked it. I think I am overlooking fewer of them, but you cannot always recognize and diagnose a very early lesion either in the bone or in the lungs. We do overlook them, but when six months or a year

later you look over your roentgenogram and find a definite metastatic nodule located exactly where you found the original little indefinite one, you must conclude that it was there at the beginning.

The next point that I would like to emphasize is that I do not believe that pneumonitis secondary to irradiation is necessary in postoperative irradiation of the lungs. I have not been getting these pneumonites, unless I find evidence of metastasis in the lungs at the beginning and I directly irradiate that with the object of overcoming the metastases. Then I get a pneumonitis, and these changes that have been described. You can avoid that by sending the rays only through the wall of the chest and not into the lung area, and by the same procedure you can avoid damage to the heart or to the blood vessels. Also less irradiation sickness will occur.

I do not believe that we should depend upon technicians to set up the roentgen therapy arrangements. It is the radiologist's job just as an operation is the surgeon's job.

Dr. Frank E. Adair, New York. Personally I would much prefer to see metastasis to the pelvis than local metastasis in the skin. A single small skin metastasis can be removed by a local surgical procedure, followed up by heavy irradiation in that area. But when there are multiple skin nodules, I think it is a difficult situation and I have never been impressed with irradiation results.

Axillary recurrence following a radical mastectomy is infrequent in the experience of good surgeons. Where one encounters a local type of recurrence in the axilla it is usually found that the case was too far advanced for operation or that the operation was poorly done.

I have not been impressed as much as some with the accomplishments of radiation therapy in the axilla though I know it contributes definitely to the five year cure rate when added to the surgery. In the case of supraclavicular involvement, I have been quite impressed with irradiation effects.

Dr. Maurice Lenz, New York. Reference was made to a paper published by Dr. Freid and myself in 1931 but this took into consideration only skeletal metastases and metastases to the central nervous system. Since 1931 Dr. Freid has extended this investigation and what we reported at that time formed only a small portion of his presentation today. It has taken fully ten years for Drs. Freid and Goldberg to gather all this material and it is not the same material.

There are two points which I would like to call attention to in his presentation of today. One is that in spite of the fact that very frequently it is thought that pulmonary and pleural metastases do not respond to irradiation, he showed you that in some of his cases he did get an improvement. And secondly, the fact that in 61 per cent of the cases of brain metastases there were originally metastases to bone. In other words, that there was an extension from the bone.

I think these are two interesting facts which are not generally noted by those who are not as familiar with these metastases as Dr. Freid has been.

Dr. White (closing). Dr. McIntosh and Dr. Farrow have touched a tender subject, the answer to which we ourselves are not quite sure about, i.e., the influence or the mechanism of pre-metastatic irradiation to the type of metastatic disease. Pre-metastatic irradiation is not the entire answer, as shown by the fact that we do have occasional nodules forming in lung fields that have been heavily irradiated. On the other hand, we do have infiltrative metastasis forming in lung fields that have had no previous irradiation at all.

Dr. Freid (closing). Dr. Lenz brought up one point about the cases with cerebral involvement that I wish to clarify. Extension from the calvarium to the meninges was not present in all these patients. It was true in many instances and that is why I spoke of cerebral involvement rather than cerebral metastases.

THE EFFECT OF IRRADIATION UPON THE COMPOSITION AND VASCULARITY OF GROWING RAT BONES*

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IN A recent publication[23] the histopathological changes produced by irradiation of growing rat bones were discussed at some length. Certain observable changes in cartilage growth and osteogenesis were encountered which were not wholly explained. Routine hematoxylin and eosin preparations are unsatisfactory for the study of calcification, ossification and vascular supply,[3] so it has been deemed advisable to conduct further investigations along these lines.

In the analysis of the microscopic preparations of irradiated metaphyses and epiphyses an intensification of the blue coloration of intercartilaginous matrix material and an apparent increase in mineralization of this matrix were noted. In addition there appeared to be actually more bone in the primary trabeculae and an increase in the depth of the metaphysis after irradiation. These changes are readily seen in Figure 1.

While some of the findings in question might be more apparent than real (due to differences in decalcification or modified affinity for hematoxylin stain), the osseous tissue increase is not likely to be an artefact.

In support of the interpretation of these appearances as actual augmentation of calcification may be cited the work of Dahl,[7] Ewing,[10] Bisgard and Hunt,[2] Engel,[9] and Gall, Lingley and Hilcken,[16] all of whom refer to increased density or sclerosis as seen on roentgenograms or in microscopic section. Opposing this view are the findings of Försterling,[13] Dahl,[5] and Phemister,[33] which indicate decalcification or absorption in irradiated bones.

None of the above mentioned investigations have included chemical studies, bone ash figures, or special staining techniques for the estimation of the mineral content in the

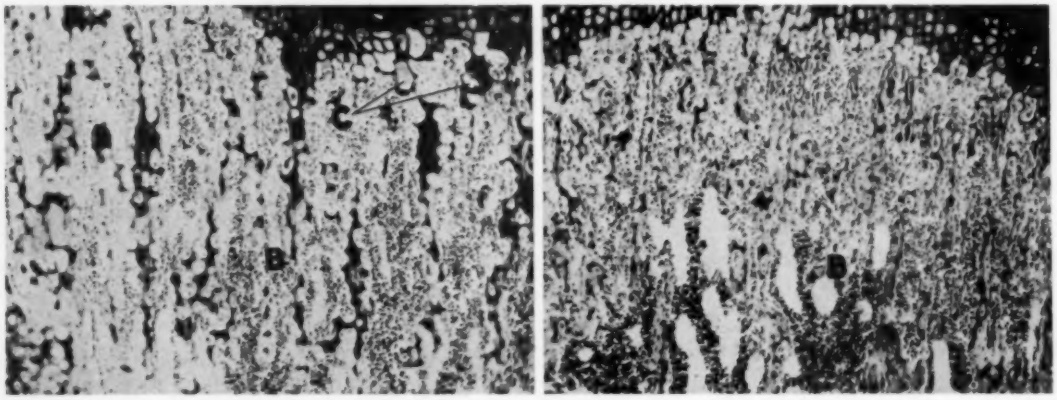

FIG. 1. *Excess metaphyseal calcification and ossification.* Photomicrographs of the distal metaphyseal regions of the femora of a rat irradiated at thirty days of age. The sections were made after an interval of one month. Animal No. 462, magnification 110×. The irradiated metaphysis (*left*) contains more blue staining mineral matter and more pink staining bone in the secondary trabeculae (*B*) than the control (*right*). A few abnormal trailing chondrocytes are surrounded by heavily mineralized matrix at *C*.

* From the Department of Radiology of the Presbyterian Hospital and of the College of Physicians and Surgeons, Columbia University, New York.

irradiated bones or cartilages.

Because of these apparent discrepancies certain experiments were carried out which may throw light on the question of disturbed mineralization following irradiation. Part I of this paper is limited to a study of the modifications in composition observed in rat femora following irradiation.

The second object of this investigation is to investigate the vascular supply of the metaphysis and base of the cartilaginous epiphyseal plate. This is also prompted by routine study of hematoxylin and eosin sections, which revealed scanty vascularization in regions where chondroclasis was deficient.[23] Other findings, such as diapedesis, long standing marrow sclerosis, and persistent derangement of growth, suggest that direct roentgen effects upon the vessels themselves might be an important basic factor in the production of the histological changes and the growth abnormalities observed.

The second part of this paper is accordingly concerned with the study of the changes in the metaphyseal arterioles and capillaries at varying intervals after irradiation.

Dahl,[6,7] in his extensive monograph, showed a scarcity of ink-injected blood vessels after huge doses of roentgen rays delivered to the hind legs of rats twelve to eighteen days old. Such dosage caused spontaneous fracture and osseous atrophy. In experimental or clinical work one seldom uses doses of this magnitude. It is therefore of value to determine whether or not the vessels are influenced by small amounts of roentgen rays in the suberythema or clinical range.

PROCEDURE AND TECHNIQUE (GENERAL) FOR PARTS I AND II

Female white rats, all thirty days old and of normal body weight, were used. These were litter mates whenever possible, and were kept under optimum conditions, fed a standard diet and all appeared healthy.

Following intra-abdominal nembutal anesthesia, each animal was tied supine upon an animal board. By means of a cone 2 cm. in diameter, a beam of roentgen rays was directed against the anteromesial aspect of the right knee. The field was large enough to include the epiphyseal cartilage zone of the distal femur and the proximal tibia, as well as several millimeters of the shaft of each of these bones.

Constant technical factors were used, these being 130 kv., 1 mm. aluminum, 8¼ inch distance, 90 r per minute. The entire dose was administered to each animal at one sitting, all animals receiving a constant dose of 950 r (measured in air).

PART I

BONE COMPOSITION

Special Technique for Part I. At intervals of one, three, seven and ten days, as well as one and two months after irradiation, animals were killed and quickly dissected in such a way as to render both femora clean and free of soft tissues, ligaments and sesamoids. During the dissection the bones were kept moistened with physiological saline in order to prevent dehydration. The bones were weighed immediately upon removal and after brisk drying of the surfaces by a rough towel. This is recorded as the "wet weight." At this time the lengths of the femora were determined by caliper measurements.

After drying to constant weight in a partial vacuum (exposed in a nitrogen atmosphere to prevent oxidation of the lipoids), the femora were again weighed, yielding the "dry weights." Next the bones were extracted for twenty-four hours in a Soxhlet apparatus and after drying were weighed again, giving "extracted or fat free weight." The bones were then ashed to constant weight in a muffle furnace, after which the residue yielded the "bone ash" weight.

The "matrix" was obtained by subtracting the bone ash from the extracted weight. Percentages of the various components were calculated on the basis of dry weights because it was recognized that certain fluctuations might enter into the net weight data.

TABLE I

DATA FROM DISSECTED AND CLEANED RAT FEMORA IRRADIATED AND CONTROLS

Number of animal	501		503		505		451	
Interval after irradiation	24 hours		3 days		7 days		10 days	
Amount of irradiation and age	960 r at 1 mo.							
	R	L	R	L	R	L	R	L
Wet weight	0.1741	0.1799	0.1724	0.1741	0.2340	0.2402	0.2505	0.2641
Dry weight	0.0722	0.0757	0.0757	0.0760	0.1069	0.1069	0.1225	0.1233
Loss in drying (water)	0.1019	0.1042	0.0967	0.0981	0.1271	0.1333	0.1280	0.1408
Percentage of wet weight lost in drying	58.5	58.2	56.0	56.4	54.3	55.5	51.1	53.3
Weight after ether and alcohol extraction (fat free)	0.0704	0.0729	0.0743	0.0740	0.1043	0.1047	0.1156	0.1177
Amount of soluble material (fat)	0.0018	0.0028	0.0014	0.0020	0.0026	0.0022	0.0069	0.0056
Percentage of fat on dry weight	2.5	3.6	1.8	2.6	2.4	2.0	5.7	4.5
Weight after ashing in muffle furnace (ash)	0.0400	0.0396	0.0431	0.0409	0.0602	0.0587	0.0668	0.0667
Matrix (extracted weight minus ash)	0.0304	0.0333	0.0312	0.0331	0.0441	0.0460	0.0488	0.0510
Percentage of matrix on dry weight	42.1	43.9	41.2	43.5	41.2	43.0	39.8	40.5
Percentage of ash on dry weight	55.4	52.3	56.9	53.8	56.3	54.9	54.5	54.0
Length of femur	18.5 mm.	18.5 mm.	19 mm.	19 mm.	19 mm.	19 mm.	20 mm.	21 + mm.
Number of animal	452		506		453		454	
Interval after irradiation	10 days		10 days		1 month		1 month	
Amount of irradiation and age								
	R	L	R	L	R	L	R	L
Net weight	0.2511	0.2792	0.2253	0.2421	0.3470	0.4091	0.3449	0.3775
Dry weight	0.1181	0.1244	0.1072	0.1118	0.1759	0.1998	0.1736	0.1879
Loss in drying (water)	0.1330	0.1548	0.1181	0.1303	0.1711	0.2093	0.1713	0.1896
Percentage of wet weight lost in drying	53.0	55.4	52.4	53.9	49.4	51.1	49.7	50.2
Weight after ether and alcohol extraction (fat free)	0.1087	0.1175	0.1037	0.1089	0.1708	0.1937	0.1673	0.1824
Amount of soluble material (fat)	0.0094	0.0069	0.0035	0.0029	0.0051	0.0061	0.0063	0.0055
Percentage of fat on dry weight	7.9	5.5	3.2	2.6	2.8	3.0	3.6	2.9
Weight after ashing in muffle furnace (ash)	0.0618	0.0636	0.0613	0.0626	0.1006	0.1121	0.0999	0.1048
Matrix (extracted weight minus ash)	0.0469	0.0539	0.0424	0.0463	0.0702	0.0816	0.0674	0.0776
Percentage of matrix on dry weight	39.8	43.5	39.6	41.5	39.9	40.8	38.8	41.2
Percentage of ash on dry weight	52.3	51.8	57.2	55.9	57.1	56.1	57.5	55.7
Length of femur	21 mm.	22 + mm.	20 + mm.	21 − mm.	24 + mm.	26 mm.	25 mm.	26.5 mm.
Number of animal	455		91		93		85	
Interval after irradiation	2 months		6 months		6 months		8 months	
Amount of irradiation and age			750 r at 1 mo.		1000 r at 1 mo.		1500 r at 11 days	
	R	L	R	L	R	L	R	L
Net weight	0.4232	0.5015						
Dry weight	0.2656	0.3063	0.5846	0.6294	0.4860	0.6195	0.2431	0.3779
Loss in drying (water)	0.1576	0.1952						
Percentage of wet weight lost in drying	37.2	38.5						
Weight after ether and alcohol extraction (fat free)	0.2549	0.2978						
Amount of soluble material (fat)	0.0107	0.0085						
Percentage of fat on dry weight	4.0	2.7						
Weight after ashing in muffle furnace (ash)	0.1660	0.1919	0.3914	0.4197	0.3262	0.4155	0.1626	0.2515
Matrix (extracted weight minus ash)	0.0889	0.1059	0.1932	0.2097	0.1598	0.2045	0.0805	0.1264
Percentage of matrix on dry weight	33.5	34.7	33.4	33.3	32.7	32.8	33.1	33.4
Percentage of ash on dry weight	62.5	62.6	67.0	66.7	67.1	67.1	66.9	66.6
Length of femur	28 mm.	30.5 mm.	35.5 mm.	39 mm.	30 mm.	37 mm.	22 mm.	33.5 mm.

In this way data were obtained for control and irradiated femora from twenty-four hours to two months after roentgen-ray exposure. These are listed in Table 1.

Included in this table are the figures for 3 animals—No. 91, 93 and 85—which showed marked stunting following heavy irradiation at an early age. These last three animals are included because they show that the interval between irradiation and bone study has an important influence upon the results. (The last three columns of figures have been previously reported.[22])*

Analysis of Results. In the analysis of the data here presented (Table 1), one must bear in mind that we are dealing not with two femora of identical size from the same animal but with an irradiated and a control femur from the same animal. The two become different as to histological appearance at about sixty hours after irradiation, and as determined by gross studies in animals of this age, growth retardation (stunting) of the irradiated bone becomes apparent at about the tenth post-irradiation day. It is well to remember that after stunting appears, the absolute weights of various components of the bone have little significance because the irradiated femur of each pair is smaller and lighter than its "control." This is the reason for the divergence of all the lines in the graph of absolute weights in Figure 2 after the tenth day. It does not explain the differences before that time, and the assumption is that they are the result of the irradiation. Figure 3 consists of the percentage content figures listed in Table 1. Here the disparity in size of the

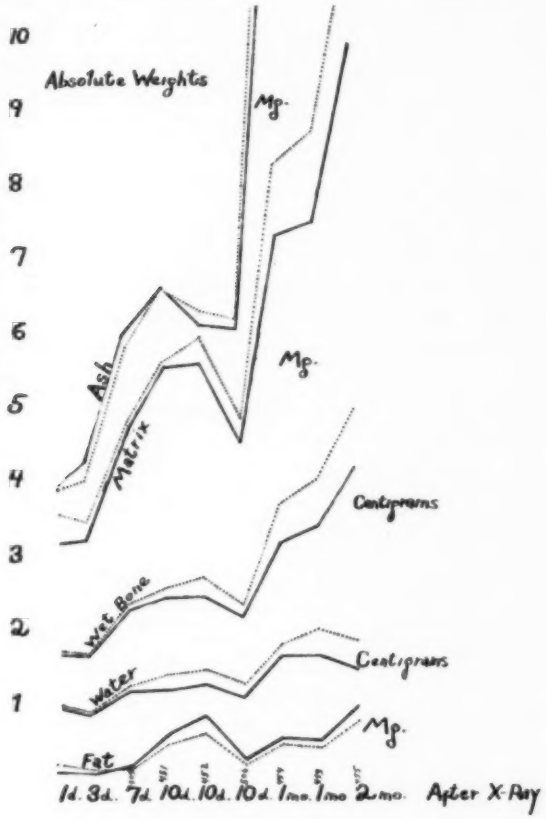

FIG. 2. *Absolute weights from Table I.* Graphic representation of the absolute weights at intervals of one, three, seven and ten days, and one and two months after roentgen irradiation. Solid lines connect the values for irradiated bones. Dotted lines connect control determinations.

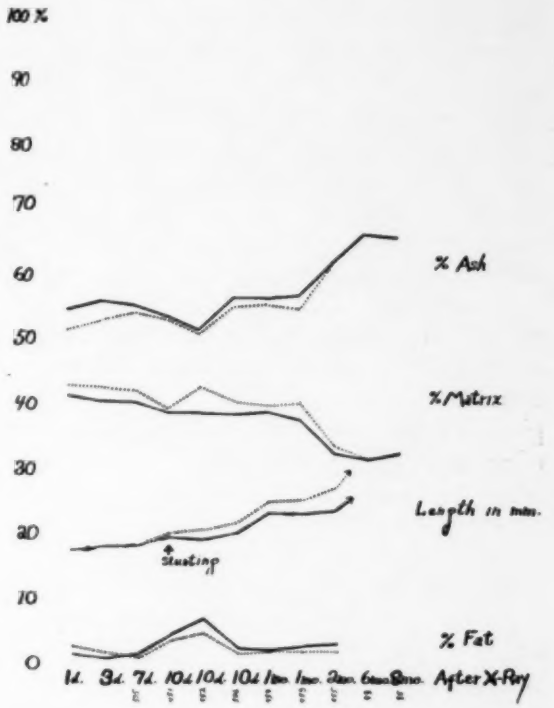

FIG. 3. *Bone composition in percentages.* Graphic representation of the percentages in Table 1. The femoral lengths are included to indicate the time at which stunting becomes apparent. The bone ash and matrix percentages merge after two months. Solid lines, irradiated bones; dotted lines, contralateral bones (controls).

* I am greatly indebted to Dr. Theodore Zucker and his staff for their technical assistance in carrying out the determinations of bone constituents listed in Table 1.

respective bones does not influence their comparisons.

Dry Weights. The dry weights and caliper measurements of length show that although microscopic abnormalities are presumably present, there is no significant difference in the weights or lengths of the irradiated and control bones of the same animal until the tenth day, at which time minimal differences are noted. This disparity becomes increasingly marked as the animals grow older and is evidence of stunting of the irradiated bone. The existence of a latent effect in roentgen effect was demonstrated in previous experiments.[22]

Water Content. The absolute weight of water is less in the irradiated bone in every determination. Although the difference is but slight, the uniformity of this finding gives it added significance. The percentage of water is slightly higher in the irradiated bone on the first day, after which in every determination there is less water in the irradiated bone.

Fat. At one and three days the absolute weight and percentage of fat is somewhat higher in the normal bones than in the irradiated ones. After the third day, however, the absolute weights as well as the fat percentage is greater in the irradiated bones. At ten days the fat content of both femora rises for reasons which are not clear, but is higher in those irradiated. This was found in 3 animals from two different litters. Although the irradiated bone is the smaller of the two, it contains more fat by absolute weight than the unirradiated control femur after the tenth day (Fig. 2).

Bone Ash. In all determinations between one day and two months after irradiation, the bone ash percentages are greater in the irradiated bones. The disparity is most marked immediately after roentgen irradiation and becomes less as the interval lengthens. It is of considerable interest that the direct weights for ash (Fig. 2) are greater for the irradiated femur at one, three and seven days even though the whole bone weights are not significantly different. At ten days the ash weights in both bones are practically identical, and from that time on, there is less ash on the irradiated side. This is, of course, due to the stunting effect.

The animals studied at six and nine month intervals after irradiation show bone ash percentages identical with those of the control bones.

Matrix. In all determinations between one day and two months after irradiation, the absolute matrix weight and percentage of matrix is decreased in the irradiated bone. This deficiency becomes progressively less marked as the interval lengthens so that after two months the matrix percentage values are found to be identical with those of the controls. The late determinations at six and eight month intervals confirm the normality of matrix.

Sources of Error. In working with bones so small it is possible to clip or chip off a small portion of cortex, which would give rise to different weights of the femora of the same animal. Error in the opposite direction may result from incomplete dissection, thereby leaving some ligamentous or muscular tag attached which would increase the apparent weight. This error, however, will be most marked in the "wet weight."

In using "wet weight" one may introduce error due to dehydration before weighing. It is also possible to "water soak" a bone if it is kept wet a long while before weighing.

Fat figures are very small (2 to 10 mg.) and small differences may cause marked shifts in percentage figures. In addition, the time and environment are important because of the known oxidation of animal fats which may take place, yielding deceptive weights. To minimize this error, no time was lost in the process and the bones were kept in an atmosphere of nitrogen (see technique).

In the face of these difficulties it is interesting to note the surprising consistency of the figures in these tables. Admittedly, the number of determinations is small and the time intervals after irradiation leave some "gaps," but the consistent differences found in these animals from different litters,

at different ages, with determinations made on different days, lend credence to their value.

PART II

VASCULAR STUDIES

Technique. The animals selected for blood vessel study were killed and the thoracic cavity opened. A glass cannula was introduced into the thoracic aorta and full strength black india ink (with 1 per cent lactic acid) was injected under gentle pressure until the tail and hind quarters of the animal became homogeneously purple-black.

The animals were then immersed and fixed in 10 per cent formalin for three days, the legs were disarticulated at the hips and excess muscular and soft tissues removed. After decalcification in formic acid, sections were cut at 25 micra and mounted unstained because of the danger of washing out the ink granules during processing.

Other femora after ink injection and fixation were sawed into thin sections without decalcification and cleared using the potassium hydroxide technique of Park.[32] This method has the advantage of permitting stereoscopic study, but in our hands was less satisfactory than the decalcified preparations.

Four additional animals, after irradiation as above, were injected by the aortic route with 45 per cent aqueous solution of lead acetate. This was done under the roentgenoscope and roentgenograms were made during the injection of the opaque material. It is necessary to time the exposures accurately, because if more than a few seconds elapse between the beginning of the injection and the exposure the lead solution passes into the fine arterioles and capillaries of the muscles and skin where, by its density, it obscures the intra-osseous vessels.

Observations at Varying Intervals after Irradiation. At intervals of one and two days after irradiation, no significant abnormalities are demonstrable in the ink-filled vessels of the irradiated bones. The number, caliber, distribution and direction of the vessels are practically identical in the epiphyseal and metaphyseal regions of tibia and femur of the irradiated and control knees. The end brushes of the delicate capillaries are found in direct contact with the large cartilage cells of Zone 5.

Figure 4 shows the normal vascular anatomy of the subepiphyseal region and

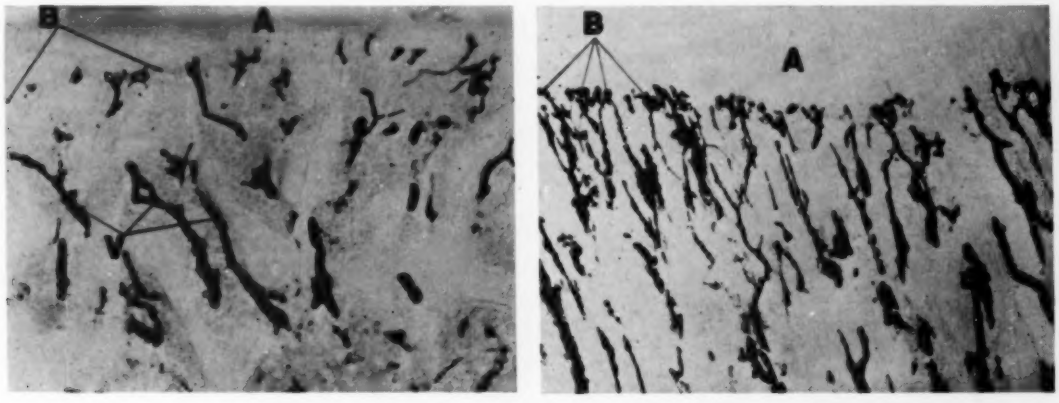

Fig. 4. *Effect of heavy irradiation upon intra-osseous vascularity.* Animal No. 495 received 1,200 r (2 M.S.D.) at thirty days of age. The sections were made ten days later. Blood vessels are outlined by ink. Magnification 110×. In the control (*right*) slender, branching vessels run through the metaphysis to end in small buds (*B*) in contact with the columns of epiphyseal cartilage. In the irradiated femur (*left*) the metaphyseal vessels appear larger and irregular in caliber (*V*). The ink injection reaches the epiphyseal cartilage (*A*) only at irregular intervals, and no vascular buds are found in the zone of chondroclasis and calcification (*B*).

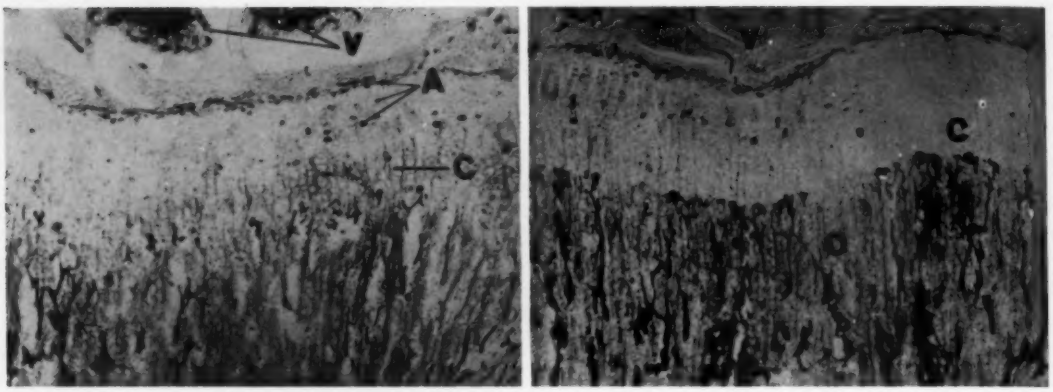

Fig. 5. *Tibia one week after 950 r administered at one month of age.* No. 442, magnification 45 ×. In the irradiated tibia (*left*) there has been some extravascular escape of ink (*V*) in the epiphysis. The granules at (*A*) are refractile artefacts, not vessels. The cartilage (*C*) is attacked by only a few narrow, irregularly distributed vessels. In the control metaphyses (*right*) filling is not perfect (*O*) but is much more complete and uniform than that of the irradiated tibia.

illustrates the marked abnormality of these vessels which may result from an exposure of nearly twice the amount of roentgen radiation generally used in the present analysis.

Three days to one week after irradiation there is a definite impairment of the ink distribution within the bones of the irradiated knee (Fig. 5). The vessels are variable in caliber but most of them are smaller than those of the control. The total number is reduced, and while the direction and linear pattern is unchanged, many of the end capillaries do not extend as far distally as the beginning of the cartilage zone. Thus, the line of capillary tufts which is normally found delimiting the metaphyseal-cartilage junction appears serrated and discontinuous.

Two weeks after irradiation it is readily apparent that although the muscles and ligaments about the irradiated knee are well injected with ink, the bones themselves contain less pigment than the controls. The individual vessels are narrower, less numerous, irregularly distributed and many end short of the cartilage zones. In general, there is a tendency toward tortu-

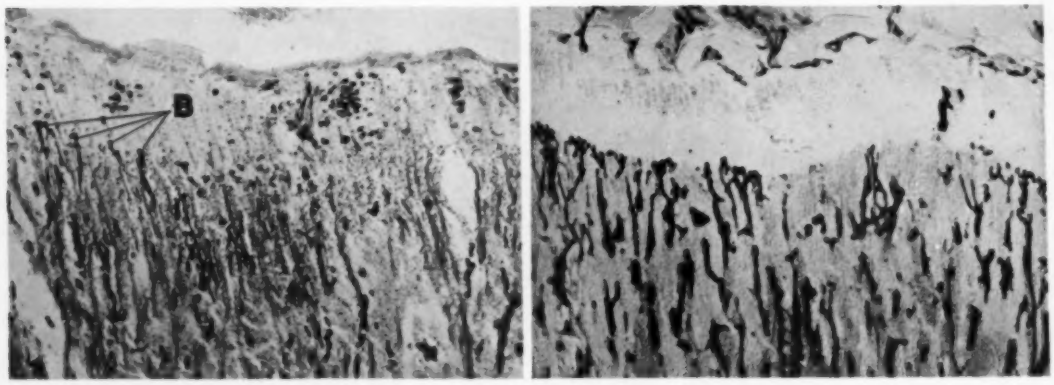

Fig. 6. *Tibia one month subsequent to irradiation.* No. 425, magnification 45 ×. Irradiated (*left*) and control (*right*) tibia. More regular linear vessels are seen in the metaphysis than in Figure 5, but the number and caliber are still subnormal. Some of the vessels extend to the cartilage zone where they end in normal appearing buds (*B*) similar to those in the control.

osity and the larger vessels appear as wavy lines of variable caliber while the delicate, finer end capillaries are decreased or absent.

Similar ink-injected preparations made a month after irradiation show definite evidence of smaller and fewer vessels on the irradiated side. At this interval, however, there is but little deviation from the normal as by this time considerable regeneration and replacement have occurred (Fig. 6).

In all of the preparations it was found that the ink entered the tibial metaphysis in greater quantity than the femoral metaphysis. The vascular supply of the proximal tibia may thus be considered richer than that of the distal femur.

The central portion of the metaphysis on section contains very little ink and there are apparently fewer vessels here as compared with the relatively rich vascularization near the cortex and periosteum. Therefore it appears that the vascular supply of the growing cartilage comes largely from the periosteal vessels rather than from the marrow cavity.

Roentgenograms of animals injected with radiopaque solution show no interference with flow of this material through the major vascular channels included in the field of irradiation. Figure 7 shows the femoral, popliteal and tibial arteries in the early stage of injection. The smaller vessels supplying the distal femoral and proximal tibial metaphyseal regions are well and equally visualized in both the irradiated and control extremities. Lateral roentgenograms show clearly that the visualized vessels lie within the bone itself. This is a gross but satisfactory demonstration of the ability of the extra-osseous arteries to withstand irradiation without interference with their function.[28]

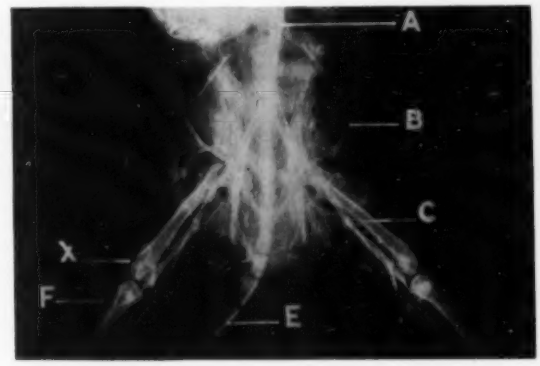

Fig. 7. *Roentgen visualization of the vessels supplying the knees.* Lead acetate solution here fills the aorta (*A*), femoral (*C*), peritoneal (*B*), and tail arteries (*E*). There is an arborization about both knees, and vessels are seen within the distal femora and proximal tibiae. The irradiation previously administered to the right knee (*X* and *F*) does not appear to inhibit the arterial injection and the extra-osseous vessels appear normal in width and distribution. Due to the stunting effect the bones of the right leg are shorter than those of the control.

Fig. 8. *Lead content of bones injected by the arterial route.* Roentgenogram of the femora and tibiae from Figure 7 after complete dissection. The opacity of the metaphyses at (*R*) (which have been irradiated) is less than that of the controls This is interpreted as evidence of diminution in volume of the vascular bed following irradiation.

In order to determine how much of the lead solution actually entered the bones, they were stripped of muscle and connective tissue attachments and the roentgenogram shown in Figure 8 was made. The dense zone in the metaphyseal regions of all bones is produced largely by the lead solution. This is more dense in the control bones than in the irradiated ones, and is best seen in the proximal end of the tibiae. This is interpreted as evidence of decreased circulatory bed in the irradiated bones, and

greater vascularity of the tibia as compared with the femur.

DISCUSSION

Roentgen irradiation appears to produce definite changes in bone composition. This is manifested by increased ash and fat, associated with low water and matrix values. It is well to consider the mechanisms involved and the possible significance of each.

Ash. The high ash percentage corroborates the histopathological findings as well as the gross roentgenographic observations of others. It appears that there is actual augmentation of mineral precipitation immediately after irradiation. Whether this is a result of hydrogen ion concentration change in the matrix substance, reduced blood supply, some ionization phenomenon, or a completely unknown effect upon the complex mechanism of precipitation, one can only surmise. The hydrogen ion concentration of cartilage is passively influenced by environment[35,36] but perhaps, as has been suggested,[21] the latter may be modified by roentgen irradiation.

The large senescent cartilage cells at the bases of the columns contain glycogen[18] and phosphatase,[12] and are thought to exert a favorable influence upon calcification.[27,37] Perhaps the excessive precipitation is augmented by the persistence of these cells which has been noted microscopically.[23] It may be that roentgen irradiation induces ionization or other changes which upset the chemico-physical balance and encourage calcification. The death of cells may play a part, as calcification is well known to be favored by necrosis or trauma.[1,24] Hypovascularity *per se* favors calcification under certain circumstances and, in the problem at hand, it is apparent that the blood supply in the subepiphyseal region is scanty as a result of irradiation. It is conceivable that not all the effects of degeneration found in irradiated cartilage cells are directly due to the roentgen rays. There may be a certain amount of anoxemia due to hypovascularity. This could produce devitalized cells, which, according to Kleinmann,[25] are more alkaline than normal cells and therefore prone to calcify.

The apparent increased true bone formation I believe to be due to deficient removal of cartilage, osteoid and bone in the primary trabeculae. The result is the presence of more osseous tissue per unit volume in the metaphysis, but the mechanism is one of deficient chondroclasis and osteoclasis rather than over-production (Fig. 1). This view is at variance with that held by others[16] who believe that it is due to increased osteoblastic activity.

There are other conditions which produce an apparent increase in density in roentgenograms but they all appear to differ in some important way from the post-irradiation changes. Among these may be mentioned the lead lines which are in part due to this metal;[31] the phosphorus lines which are said to be due to increased osteoblastic activity;[15,31] experimental magnesium deficiency;[29] and long continued estradiol benzoate administration in rats.[8] There are many other causes,[14,17,40] but those mentioned have been investigated and substantiated by bone ash determinations and histological studies. The dense "lines of growth arrest," described by Harris,[19,20] are morphologically similar in some respects to the post-irradiation changes.

Fat. The high fat content in the irradiated bones is more readily understood. It has been noted by nearly all observers,[4,5,26] and appears to represent merely a replacement of the destroyed marrow cells, similar to that found in other types of bone marrow injury or depression. We cannot exclude the possibility that blood vessel diminution may contribute in some part to the injury of the marrow cells.

The fat rise about the tenth day in the control bones remains unexplained unless one assumes that it is a result of either the general anesthesia or the period of starvation accompanying it at the time of irradiation.

Matrix. The amount of matrix is a relative value as it is determined by subtrac-

tion of the bone ash from the extracted weight. The low matrix values after irradiation are a natural consequence of the increased ash content.

Water. The low water content following irradiation is somewhat more difficult to explain. As roentgen rays are considered to be cell damaging or traumatic, one might expect them to produce edema, yet the data here indicate decreased water within the bones. Thirty-seven to 58 per cent of the total "wet weight" of the femora used in this work is water which is contained within cells, in the intercellular spaces and in blood vessels. Since roentgen irradiation decreases the amount of demonstrable vascular bed, I am led to suggest that the resulting decreased intra-osseous blood volume may be the direct cause of the lowered water content.

CONCLUSIONS

Roentgen irradiation of the femora of young growing rats is followed by an almost immediate increase in bone ash and fat content, associated with a drop in matrix and water. The mechanism of augmented mineral deposition is not clear. It is associated with a compensatory decrease in matrix.

Several days after irradiation there follows a demonstrable diminution in the number and caliber of the metaphyseal blood vessels. The resultant relative avascularity may well be a basic factor in the production of the high ash and low water contents observed.

In the months after irradiation of the intensity used in these experiments, there is a gradual return toward normal content of ash, matrix and fat. Although there is considerable regeneration of vessels, some degree of hypovascularity persists throughout the period of observation.

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AN UNUSUAL CASE OF PULMONARY OSTEOARTHROPATHY IN A DOG*

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SINCE Bamberger[1] described the first case of pulmonary osteoarthropathy in 1889, several hundred papers have appeared, describing the clinical, pathologico-anatomical and roentgenologic aspects of the disease. Locke[3] and Crump[2] list more than two hundred papers in their references. But in spite of this, the cause and explanation of the disease are still unknown and an entirely convincing theory to explain the peculiar bone changes found in chronic chest conditions is still lacking.

The disease has also been reported in animals. The lion, horse, cow, hen, and dog have been affected and the latter appear to be particularly susceptible to the disease (Wirth,[6] Stang and Wirth,[5] Poley and Taylor).[4] Of 18 reported cases of osteoarthropathy in dogs, 16 were due to pulmonary tuberculosis.

FIG. 1. Roentgenogram of hind leg, March, 1941.

The following is the report of a case in a dog, which is unusual inasmuch as (*a*) the disease was due not to tuberculosis but to a pulmonary neoplasm, (*b*) it was diagnosed by roentgen examination during life, (*c*) the animal was operated upon and the diagnosis confirmed.

The owner of the dog first noticed moderate swelling of the legs and slight difficulty in walking in March, 1941, at which time no pulmonary symptoms were present. A roentgenogram taken at that time (Fig. 1) showed slight deposition of new cortical bone of the legs and feet. The diagnosis of pulmonary osteoarthropathy was established at this time on clinical and roentgenologic findings. The electrocardiogram and blood chemistry were within normal limits and remained so during the entire course of the disease.

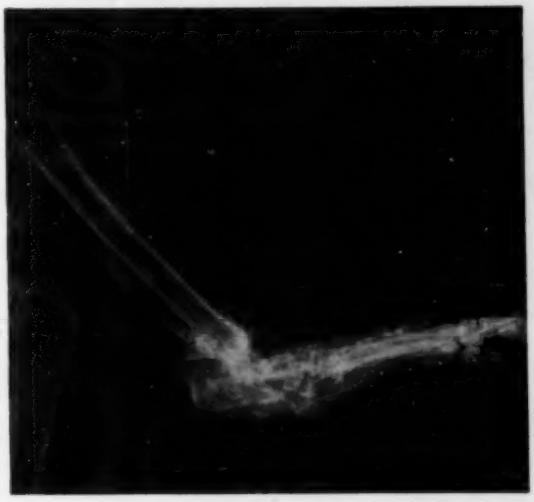

FIG. 2. Roentgenogram of hind leg, June, 1941.

The dog became progressively worse, swelling of the legs became more pronounced, and in June, 1941, another roentgenogram was taken (Fig. 2). This showed a marked increase in the periosteal depositions consisting of several layers on all bones of all extremities.

* From the Department of Radiology, Massachusetts Memorial Hospitals, Boston.

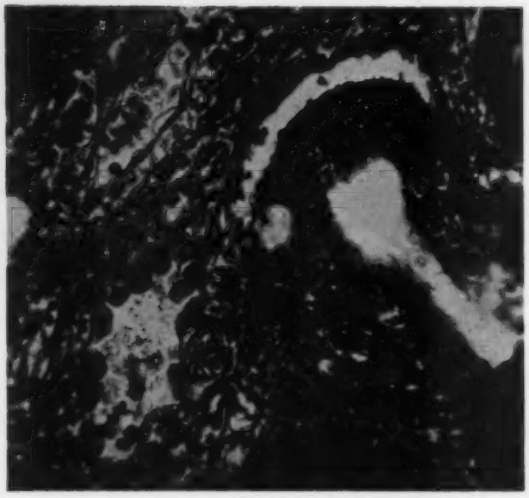

Fig. 3. Low power photomicrograph of excised tumor.

The dog was subsequently operated upon and a spherical encapsulated tumor, measuring about 3 cm. in diameter, was removed from the upper lobe of the lung. The lung otherwise had a normal appearance. However, on microscopic examination the tumor proved to be a highly malignant invasive bronchogenic carcinoma (Fig. 3).

Following the operation there was an apparent marked improvement in the condition of the dog. Swelling of the legs decreased, the animal gained about 15 pounds and became active and lively.

However this improvement lasted only about four months. The swelling returned and became more marked, pain was outstanding, weight loss recurred and a roentgenogram showed an extreme degree of the previously noted changes (Fig. 4 and 5).

The animal's condition became progressively worse and a short time afterwards euthanasia was performed.

Autopsy revealed extensive recurrence of the bronchogenic carcinoma throughout the entire right upper lobe with beginning necrosis in the center of the tumor. However, there was no evidence of metastasis elsewhere in the body. The skeleton showed enormous depositions of connective tissue along all the bones of the fore and hind legs, but no metastases were present. (Autopsy, courtesy of Dr. O. Pollak, Taunton.) The roentgen diagnosis of pulmonary osteoarthropathy was confirmed by the pathologist.

Fig. 4. Roentgenogram of hind leg, October, 1941.

Fig. 5. Roentgenogram of fore leg, October, 1941.

SUMMARY

A case of pulmonary osteoarthropathy in a dog is described with unusually extensive bone changes.

We believe that this is the first case reported in this country in which the disease was diagnosed roentgenologically in an animal during life, and confirmed by surgical operation.

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RELATION OF FOCAL SPOT TO FIELD DISTRIBUTION

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THE measurement of field distribution shows that many fields are asymmetrical and irregular.[1] The cause frequently is due to the focal spot being off center. Where cones are designed for point sources of roentgen rays with small openings near the tube, if the target is off center the radiation may come out through the side of the cone and the usable field at the bottom may be reduced to half as much as the cone should give.

A simple method of finding the location of the focal spot is to make a pinhole exposure through lead on a film where the center is indicated by the crossing of diagonal lines marked with a stylus on the black paper enclosing the film.

METHOD

This paper will describe the method of making pinhole pictures in detail so that anyone can follow it.

Take a roentgen film leaving it in its folder of black paper. Enfold it in another sheet of black paper so that one surface is smooth. With a hard lead pencil draw the diagonals of the film on the smooth surface of the black paper. At the center where the diagonals cross draw a set of perpendicular lines (see Fig. 1). The designation of the target side, *N*, *S*, *E*, and *W*, or whatever notation is desired, can also be made on the film through the black paper. When the film is developed these lines appear as unexposed lines. Place this film on a table and bring the cone of the roentgen tube down so that the lines on the side of the cone touch the perpendicular lines on the film and the surface of the cone is parallel to the surface of the table (Fig. 2). Then secure the film on the table with adhesive tape or

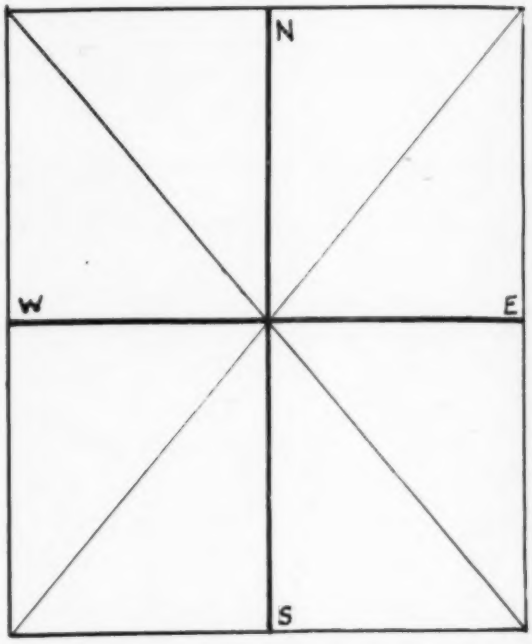

FIG. 1. Diagram of wrapped film with diagonal lines.

labels. Fix the tube so that it can move only vertically.

At a distance above the film equal to the distance of the opening in the tube head from the target, place a sheet of lead about 1 foot square or enough to completely cover

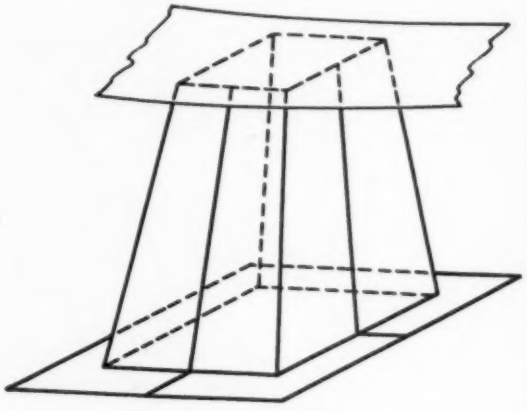

FIG. 2. Diagram of film on table and method of centering.

[1] Jacobson, Lillian E. The importance of field distribution measurements. AM. J. ROENTGENOL. & RAD. THERAPY, 1941, *46*, 719–726.

the opening. This sheet should be about 1 to 2 mm. thick with a pinhole in the center. It can be put on a wooden footstool of the correct height or held by means of any convenient holder. Care, however, must be taken to have the hole in the center. To do this, mark the lead sheet in the same manner as the film using any sharp instrument instead of the pencil (Fig. 1). At the center

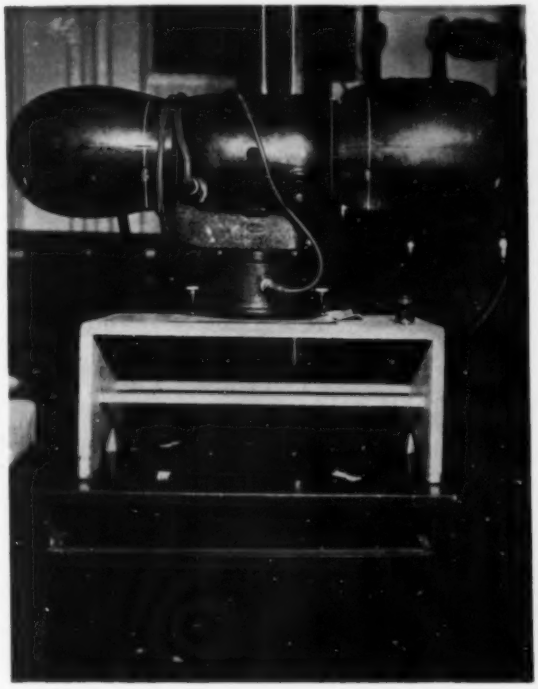

Fig. 3. Photograph of actual setup with film, lead and stool.

where the diagonals cross, punch a hole with a large needle or other instrument of about 1 mm. in diameter. Smooth edges are obtained if the hole is made by a single blow. Have the lines on the cone match the perpendicular lines on the lead in the same way as for the film. The hole is then in the center.

Now remove the cone and bring the tube down so that the target is the same distance above, as the film is below, the lead. This will give a pinhole picture the same size as the target (see the setup in Fig. 3). If this target distance is not feasible, any other target distance can be used, and the size

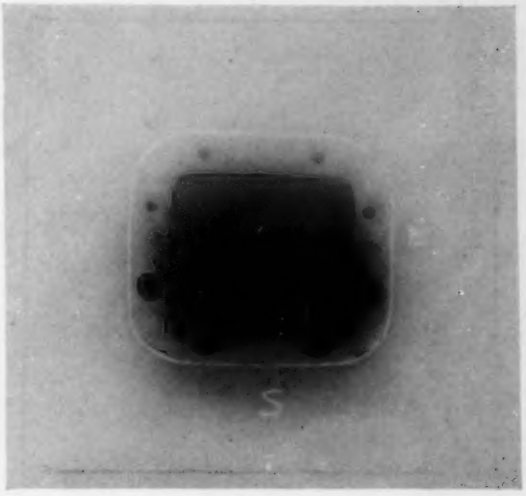

Fig. 4. A 4 by 5 cm. cone with half the field cut off.

of the target is to the size of the pinhole image as the distance of the target from the pinhole is to the distance of the film from the pinhole, i.e.,

$$\frac{S_{(target)}}{S_{(picture)}} = \frac{DIS_{(target)}}{DIS_{(film)}}$$

A good exposure is about 30 r at the film, i.e. 30 r would reach the film if the lead were not placed in the path.

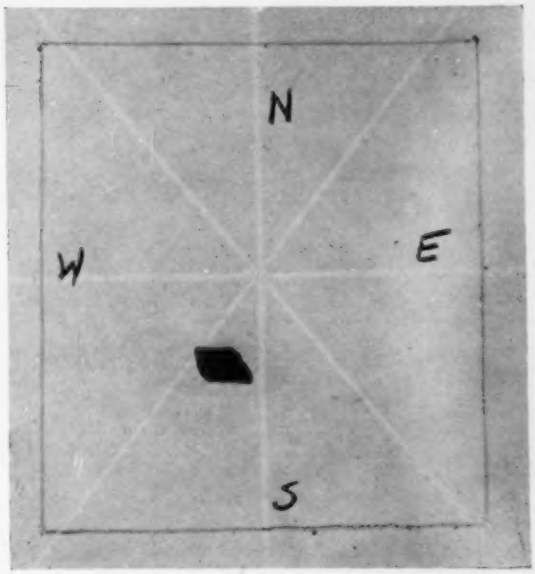

Fig. 5. Pinhole picture showing target 2.5 cm. off center.

The film is developed in the usual manner.

Figures 5, 10, 13, 15 and 17 are pinhole roentgenograms taken by the above simple method. This method with slight variations can be adapted to almost any equipment.

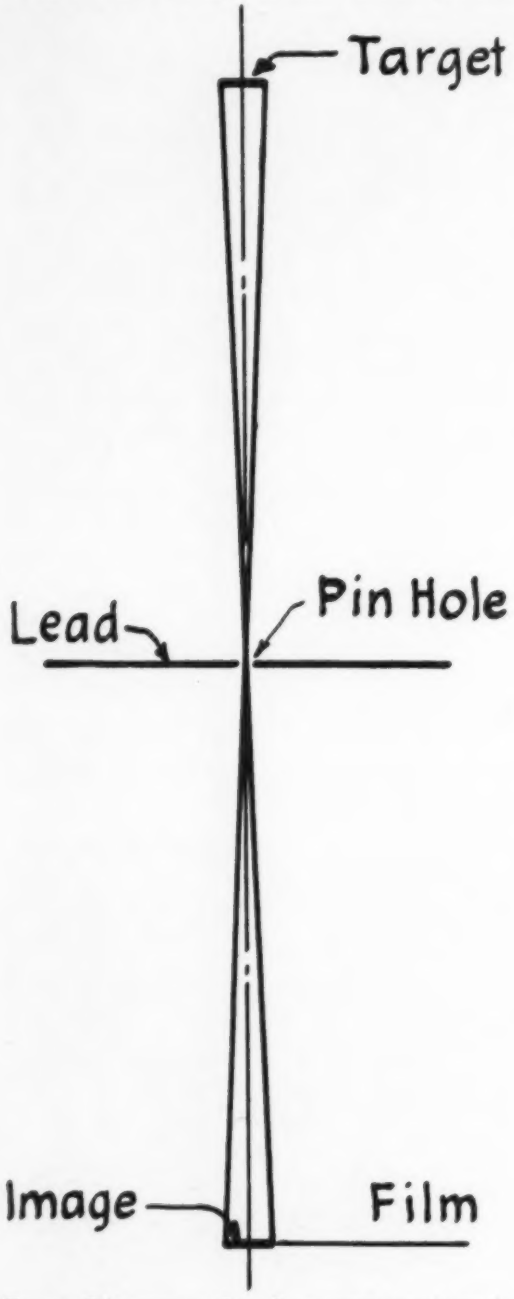

Fig. 6. Diagram to show how target produces its pinhole picture.

Any number of other methods could be used. A permanent setup could be made where the film and lead with the pinhole could be mounted in a box or a cheap box camera. In each case some method of indicating the exact center on the film should be devised so that one can tell at a glance in which direction the target is displaced. One should then also keep in mind that a slight displacement on the film means a greater displacement of the target in the same ratio as the target distance from the lead is greater than the film distance from the lead.

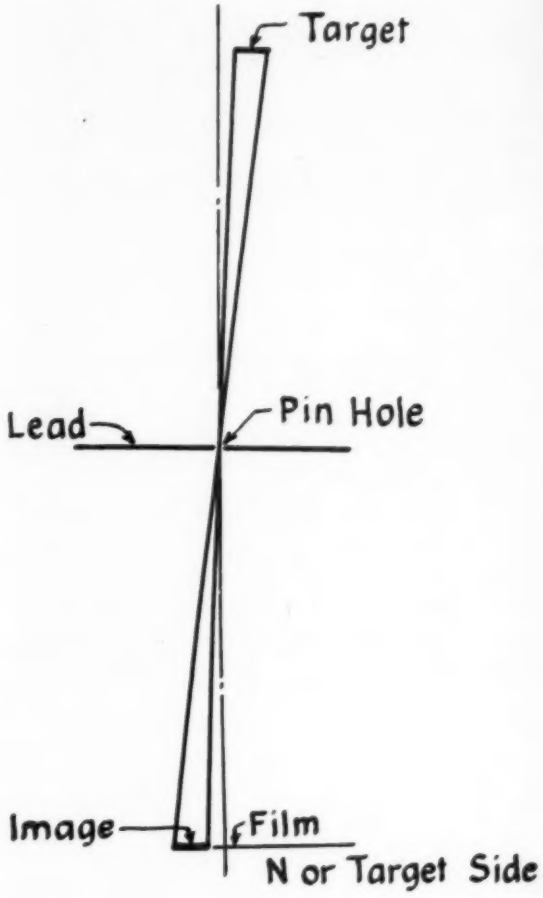

Fig. 7. Diagram to show how off center target produces its pinhole picture.

RESULTS

Dosage rate measurements on a 4 by 5 cm. cone showed that about half the

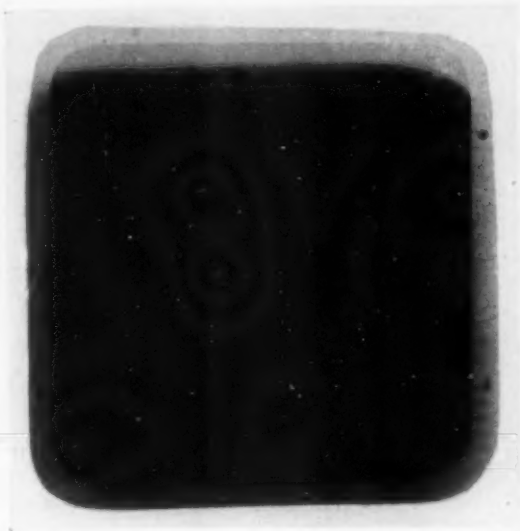

Fig. 8. A 15 by 15 cm. field of off center tube.

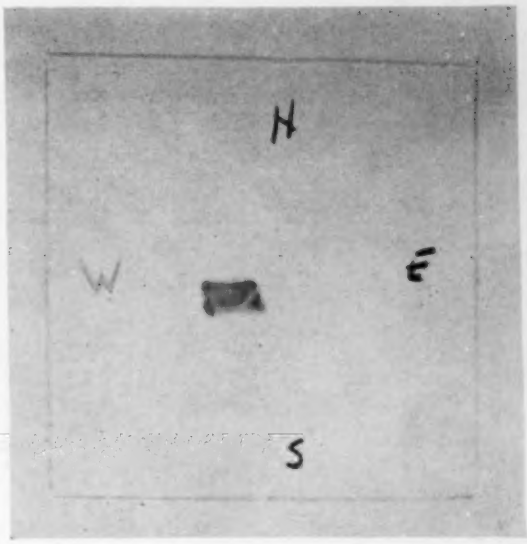

Fig. 10. Pinhole picture of correctly centered tube.

amount of roentgen rays were received as could be expected. A roentgenogram of the field was taken and it showed that about half of the field was cut off (Fig. 4). *N* is the target side. Examination of the cone showed that the opening in the diaphragm near the tube was centered and was just sufficient to give a 4 by 5 cm. field, provided the target were centered.

A pinhole picture was taken (Fig. 5) which shows that the image of the target was removed 2.5 cm. from the center toward the *S* side and 1 cm. toward the west side. *N* and *S* are along the long axis of the tube. *E* and *W* are perpendicular to this axis. This means that the target is displaced in the opposite direction 2.5 cm. toward the *N* or target side and 1 cm. toward the east.

Figure 6 shows how the target produces its pinhole picture when centered. Figure 7 shows that if the target is displaced toward one side its image is displaced to the opposite side.

This target was sufficiently displaced that even large fields were off center (Fig. 8 and 9).

This tube was declared non-usable, returned to the dealer and replaced by another tube. In this new tube the target was almost at the center (Fig. 10). The 4 by 5 cm. field at 80 cm. was completely covered

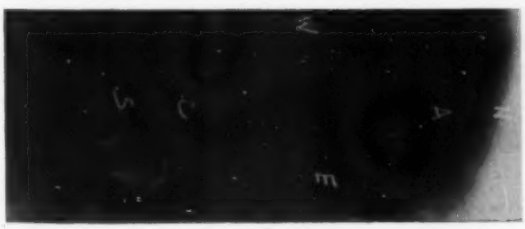

Fig. 9. Field of tangential cone of off center tube.

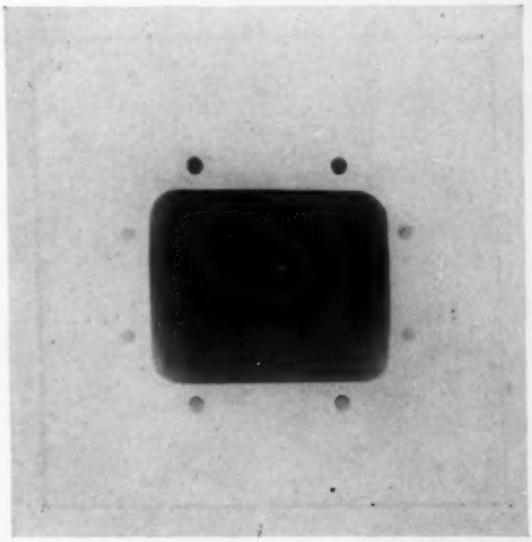

Fig. 11. A 4 by 5 cm. field with target in center.

Fig. 12. Field of tangential cone with target in the center.

or almost uniform, as shown in Figure 11, and the large field of 29.5 by 11.5 cm. made by the tangential cone at 50 cm. focus-skin distance was completely blackened except for the farthest corner on the target side (Fig. 12).

The pinhole picture of another tube which was found non-usable because the field came out the side of the cone instead of the bottom is shown in Figure 13. The target is about 2.5 cm. off center toward the anode side. Figure 14 is a roentgenogram taken directly under the opening in the tube holder. It shows the cut-off on the target or north side due in part to the target being off center. This tube was replaced by another whose pinhole picture is shown in Figure 15. It is a little more than a centimeter off center but usable for our purposes, for the 4 by 5 cm. field

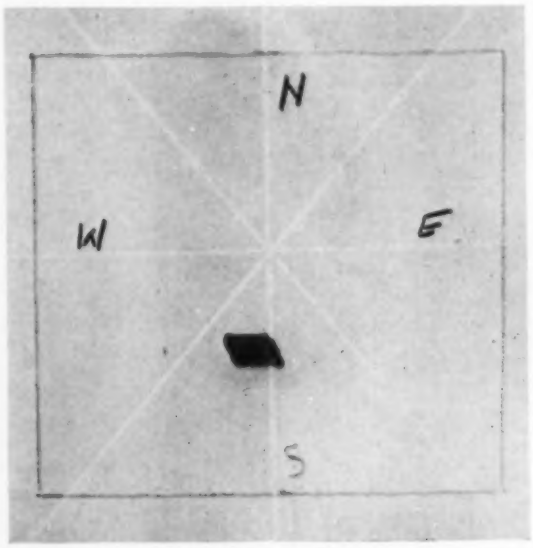

Fig. 13. Pinhole picture of off center target.

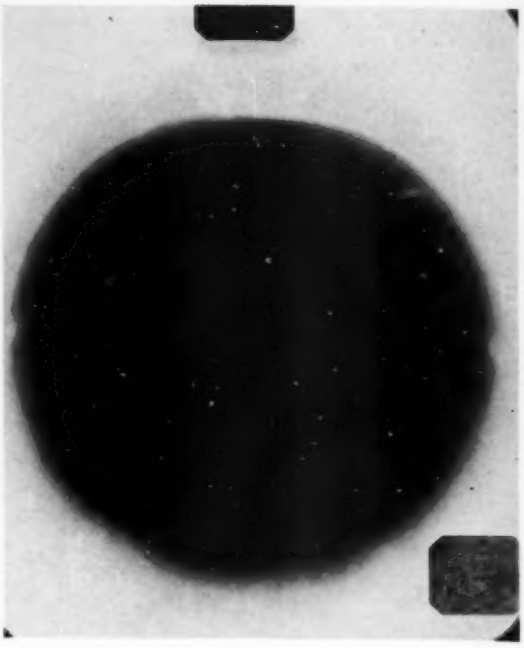

Fig. 14. Roentgenogram of tube opening at 27 cm. focus-skin distance with off center target.

(Fig. 16) is almost completely covered with the exception of a few millimeters toward the north side.

With the exception of one tube in this tube holder all the tubes of which pinhole

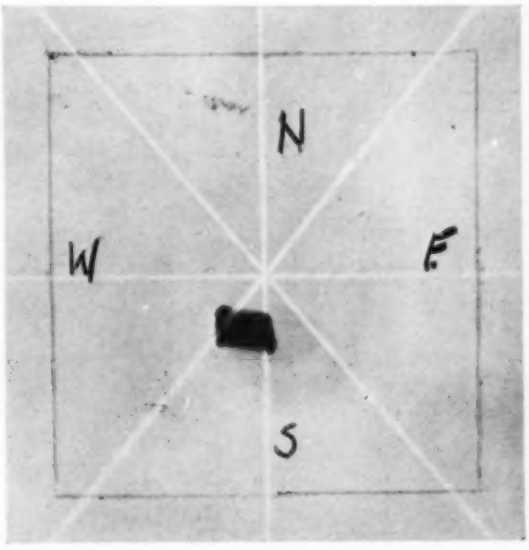

Fig. 15. Pinhole picture of target 1 cm. off center.

pictures were taken were off center 1 cm. or more.

Another make of tube in a different tube holder yielded more encouraging results. The target was centered most of the time (Fig. 17).

DISCUSSION

The questions arise: What is the objection to having the target off center? How far can a target be off center and still have a usable tube? These questions are intimately related to the size of the focal spot, the size of the opening in the limiting diaphragm and its distance from the target. It is assumed here the opening in the diaphragm is correctly centered.

If the source of roentgen rays were a point or a few millimeters square and exactly in the center of the tube, an opening in the diaphragm just sufficient to allow the field to be covered by roentgen rays could be used. But these conditions do not obtain in roentgen therapy, for the target is at least 5 mm. square and in most cases much larger. It is seldom exactly in the center, and the opening in the diaphragm may be off center, or the cone may be attached so that the opening is not exactly centered. Therefore the diaphragm opening should be large enough to take care of these disalignments. Accordingly, those cones which are built with the limiting diaphragm opening just sufficient for a point source of roentgen rays are not very desirable.

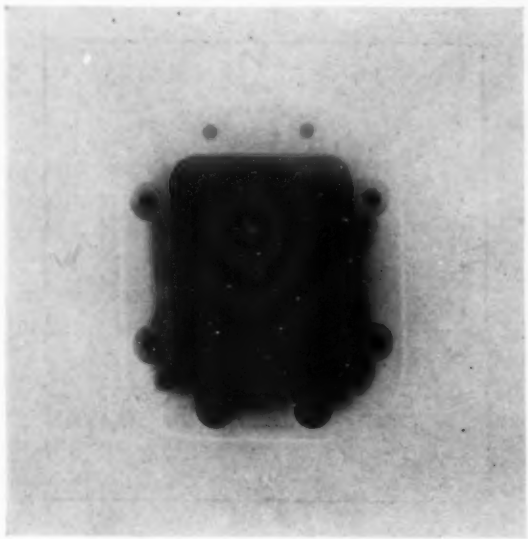

Fig. 16. A 4 by 5 cm. field with target 1 cm. off center.

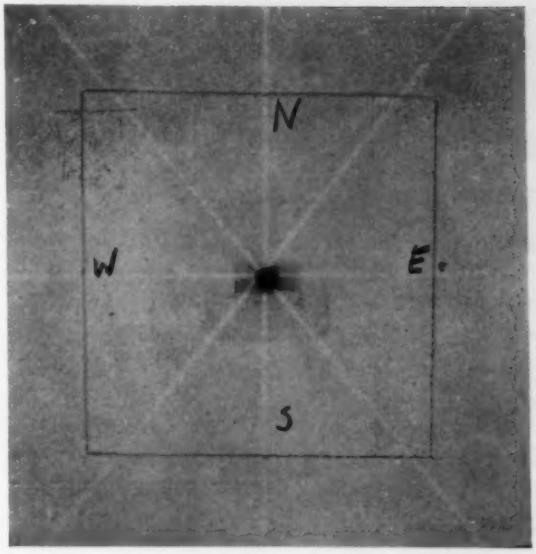

Fig. 17. Pinhole picture of different kind of tube in different tube head.

Now if, as is generally the case, the source of roentgen rays is a large focal spot as 1.4 by 0.7 cm. in the one presented in this paper and the limiting diaphragm is half way between the field and target, there will be a penumbra of about 14 mm. all around the main beam and 7 mm. of this penumbra will escape through the sides of a cone whose diaphragm is designed as above.

If the focal spot is shifted 2.5 cm. off the center for a 10 by 10 cm. field at 50 cm., when the diaphragm opening is 5 by 5 cm. at 25 cm., 2 cm. of the field will not be touched by direct roentgen rays while on the opposite side the rays would escape through the side of the cone to cover a field approximately 3 cm. beyond the desired field. Such a field is definitely not usable.

In order to have the field covered on the side of the shifted target, the diaphragm opening will have to be increased by 2 cm. Meanwhile on the opposite side, the roentgen rays escape through the side of the cone 5 cm. beyond the desired field. In order to prevent this, the cone would have to be

lead lined for 19 cm. on this side. This makes the cone quite heavy.

It is clearly seen that such a displacement of the target from the center is not usable.

Let us see what happens if the edge of the focal spot is displaced 1 cm. from the center. Then 1 cm. of the field on the side toward which the displacement occurs does not receive direct roentgen rays. On the opposite side, the roentgen rays cover about 2.5 cm. beyond the desired field. In order to have the entire field of 10 by 10 cm. covered, the diaphragm opening would have to be 1 cm. larger. Now the 10 by 10 cm. field is covered but the rays extend about 3.5 cm. beyond the edge of the field. To prevent this, the cone on that side would have to be lead lined for 16 cm. What usually happens is that the diaphragm opening is almost large enough to allow a 10 by 10 cm. field to be covered when the focal spot is displaced 1 cm. from the center. Roentgen rays escape through the sides of the cone beyond the field with decreased intensity due to the absorption by the metal in the cone. This field is usable but is certainly not ideal. The purpose of the cone is lost as a protecting device if this condition obtains.

The ideal cone has yet to be designed. It is suggested that at the top there be a limiting diaphragm with an opening large enough to allow rays to more than cover the desired field so that if a large focal spot is displaced about 1 cm. from the center the rays still cover the field. Another limiting diaphragm should be placed near the field, sufficiently high up in the cone, however, to prevent rays coming from the first opening escaping through the sides. Below the second diaphragm where rays may go through the sides the cone should be lead and aluminum lined.

No definite rules can be given for all cones.

The cones should be designed for the tube and the tube holder on which they are to be used. The size of the target, the tube holder, length of the cone and field size should be taken into account. It is dangerous to take a cone for one type of tube holder and use it for another unless the field and scattering are checked.

In all events, it is good policy to surround the field opening on the patient with lead rubber in case cones are not properly designed or in case the target is off center and rays are coming out the side of the cone.

The question arises: How can the displacement of targets off center be avoided? To answer this question with questions: How much do individual tubes of the same manufacturer differ from each other? What provision have equipment manufacturers made for this individual difference in tubes? Are tube openings and drum openings always aligned? How much shifting does the tube holder allow? It is believed that the manufacturers with a little investigation and cooperation can solve the displacement problem so that the focal spot is not more than 0.5 cm. off center.

SUMMARY AND CONCLUSIONS

1. A simple pinhole picture method of making a roentgenogram of the focal spot and finding its displacement from the center is described.

2. Pinhole picture roentgenograms of various focal spots and the fields obtained with these focal spots are shown.

3. Focal spots being off center may cause:

(a) the loss of radiation over a considerable portion of a small field;
(b) and for larger fields the loss of radiation over several centimeters;
(c) the radiation to come out the side of a cone and strike the patient where least desired.

4. It is recommended that fields be surrounded with lead rubber to take care of the above stray radiation.

5. A general outline of the design of cones is given.

6. Manufacturers of equipment should take account of the variation in individual tubes and leave sufficient play in the tube head so that these tubes can be properly centered.

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EDITORIALS

THE ART OF ROENTGENOSCOPY IN GENERAL, AND ITS USE IN THE STUDY OF THE COLON IN PARTICULAR

AMONG the wonders of the growth of radiology not the least has been the development of the science and art of the study of the gastrointestinal tract. Pioneers, such as Carman and Cole in this country and Åkerlund, Berg and Forssell abroad, elaborated most of the principles upon which modern practice in this field is based. The great advances in engineering design which have been utilized in the last few years in the manufacture of roentgenoscopic and roentgenographic equipment have made scientific precision in gastrointestinal roentgenology within the reach of every radiologist. Now in roentgenoscopy, roentgen tubes with fine focal spot can be employed capable of supplying an almost continuous beam of roentgen rays at a voltage of 80 kilovolts. For short periods, such a tube can be heated with a 10 milliampere filament current during roentgenoscopy instead of the customary 5 ma. Such a temporary boosting of the current during roentgenoscopy allows for better illumination on the screen when very dense portions of the body are being examined, and its advantages have been fully discussed by Chamberlain[1] in a recent article. Brilliantly responsive fluoroscopic screens, compression devices, so-called multiple "spot film" devices, and those allowing numerous serial exposures with the Potter-Bucky diaphragm using a single 10 by 12 inch or 14 by 17 inch cassette, are additional factors contributing to the high quality which every roentgenologist should obtain as a matter of routine in the technical part of any gastrointestinal examination. Still further revolutionary advances in roentgenoscopy by the adaptation of the energy of the electron beam, with its potentialities for magnification and intensification of the roentgenoscopic image, have been predicted by Chamberlain.

Truly, science has endowed us with vision which the most eminent gastroenterologist of fifty years ago could not have imagined. And it may be that some roentgenologists, carried away by enthusiasm for these technical triumphs, have lost sight of the art of the gastrointestinal examination which was bequeathed to us, along with the science, by the great physicians of an earlier day. The artist in radiology, just as in any other field, must be able to appreciate fundamental concepts in his surroundings and translate and fuse them in such a way that the result will contribute to the comfort, happiness or pleasure of mankind. In medicine this idea was formerly exemplified by the "bedside manner" of the physician, and since this term has come into some disrepute, it is now customary to convey somewhat the same thought by the phrase "clinical approach." The suggestion in these terms is that the patient should be considered as a human being and his symptom complex interpreted as a whole; as a matter of fact, too often during gastrointestinal roentgenology, events conspire to make of him a physical phantom, containing a hollow tube into which a barium mixture may be poured at both ends.

Inasmuch as the roentgen examination of the gastrointestinal tract is based primarily upon roentgenoscopy, an opportunity for personal contact between patient

[1] Chamberlain, W. E., Fluoroscopes and fluoroscopy; Carman Lecture. *Radiology*, 1942, *38*, 383–413.

and physician is presented which should not be neglected. It would be well if we could all possess the legendary charm of Russell Carman who so quickly put the apprehensive patient at his ease. Failing in this, we can at least remember that the dimly lit roentgenoscopic room, filled with familiar apparatus, in which we feel so much at home, can be to the stranger a foreboding den containing the paraphenalia of black magic. Anything we do to reduce this atmosphere of mystery, such as inquiring about the patient's home life or occupation, or maintaining a casual conversation about commonplaces, will gain for us his appreciation. Even more important is the fact that by putting the patient at his ease we interrupt disturbing psychic stimuli to his gastrointestinal tract and so help eliminate some of the factors which can so confuse the picture of disease. Finally, no complete grasp of the medical problem can be obtained without the roentgenoscopist obtaining his own account of the history from the patient himself. The roentgen examination is, after all, only a part of physical diagnosis with special methods and is applied to a person who is ill (patient) by a physician (radiologist). One cannot look at roentgenograms and construct a reasonable analysis of disease without some personal contact which results in coloring the objective findings by virtue of the past experience of the radiologist.

It is particularly in the barium enema examination that we often fail to individualize our practice as we should. Because the yield in positive findings is low in barium enema studies when compared with examinations of the upper gastrointestinal tract, many roentgenologists exhibit little interest in the colon examination and perform it in a stereotyped and perfunctory manner which contributes further to their high percentage of negative results.

Preparation of the patient should be attempted as the initial step because it is difficult to interpret findings in a colon filled with feces. Castor oil has been found to produce the most thorough evacuation of the colon but it is often too drastic and results in irritability of the bowel which hampers proper study. It is usually wiser to allow the patient to take some other laxative to which he is accustomed, or to rely on a simple cleansing enema given on the morning of the examination.

The second important step in the examination is to reassure the patient. Nine out of ten persons undergoing this study are filled with apprehension at the prospect of a public enema, given by strangers, with no toilet anywhere in sight. There is no situation in which the kindness and understanding of the physician is more appreciated. The third important point is the temperature of the opaque medium. To produce the least shock to the patient and reduce the likelihood of cramps, spasm, and incomplete retention, the enema should be administered at body temperature. This means, if 4 or 5 feet of tubing are used between can and tip, that the temperature of the fluid in the can must be about 101° F. Of equal importance is the rate at which the solution enters the colon. Often, habit or lack of time, causes the roentgenologist to place the enema can about 4 feet above the patient. The sudden, rapid filling and distention of the colon which ensues makes it impossible for the observer to keep abreast of and study the head of the advancing column with sufficient care, and impossible for the patient subsequently to evacuate completely enough to make the post-evacuation examination of any value. Ideally, the enema should advance very slowly and intermittently, and this can be accomplished by maintaining the enema can about 6 to 10 inches above the table top. By this method of filling, ample time is permitted for unhurried palpation and minute study of the advancing portion of the column. No attempt should be made to distend the colon or force the barium back into the terminal ileum, unless the examination is directed specifically to the ileum. It will be found that the colon, if it has not been overdistended, will almost always evacuate the barium completely when it is

given the opportunity, and present a very valuable pattern of the mucous membrane, which forms a perfect background for an air insufflation should a double contrast study be necessary.

In examinations where spasm and discomfort are prominent in spite of gentle introduction of the enema, it has been found useful to administer benzedrine sulfate, either subcutaneously or as a tablet dissolved under the tongue. It is remarkable how rapidly 10 mg. of the drug will relax the bowel and render an examination easy which would have been otherwise impossible. Often the use of benzedrine becomes of importance in the differential diagnosis of an obstructing lesion in the colon. Occasionally spasm alone will be prolonged and complete enough to simulate an organic narrowing. This is particularly likely to occur when there is a real obstructing organic lesion in a more proximal portion of the colon, and the precise location of the disease will depend, then, upon the correct interpretation of the several persistent areas of narrowing which may be encountered. The use of benzedrine will result in relaxation of the spastic areas but will not affect the narrowing due to organic disease.

Occasionally, one will encounter a patient, usually elderly or uncooperative, who is unable to retain the enema even when it is given under the most favorable circumstances. These individuals may have had a third degree perineal tear or neurogenic disease which has left them with an entirely relaxed anal sphincter, or they may be resistant and antagonistic and not wish to cooperate. It is possible to study such patients in the usual way provided some kind of anal plug is used to help them retain the enema. One of the devices which has been found very suitable for this purpose is a short, double-barrelled metal enema tip with two limbs at one end for receiving rubber tubing. The enema flows through the inner metal tube in the usual way. The outer sleeve of the metal tube can be connected to a rubber manometer bulb or some other source for slowly introducing air. At the tip end of the metal sleeve are several small holes, and over these openings a small rubber balloon is fastened, which can be maintained, slightly inflated, after the enema nozzle has been inserted into the rectum. The inflated balloon forms an effective anal plug and can be easily checked as to position and size during roentgenoscopy.

The roentgenoscopic study of the colon while the barium enema is being administered is the most important part of the examination. It is necessary to observe the patient in various oblique postures and in the lateral position during palpation. Only in this way can the colonic flexures be separated and each individual segment of the bowel brought into view. The rectum is best seen in the lateral position, and the sigmoid in a 45 or 60 degree oblique with the patient turned to the left. In cases where a low obstruction is encountered, the patient should be placed in the knee-chest position, for occasionally pelvic tumors which press on the sigmoid will fall away when the patient adopts the knee-chest position, and an obstruction to the barium column will be relieved. In studying the cecum it is often useful to have the patient erect, to utilize the effect of gravity in filling this region and determining its mobility. Again, observation of the patient in the prone position will reveal the presence of even large polyps which were entirely overlooked when the patient lay supine.

In instances where filling is difficult due to retained feces, spasm or organic disease, it may be wise to siphon off the enema or allow the patient to evacuate it and repeat the entire procedure, perhaps several times.

After the bowel has been completely filled with barium, appropriate roentgenograms should be obtained and the patient allowed plenty of time to evacuate the enema in the toilet. This usually requires fifteen or twenty minutes for it has been found that many patients will not evacuate

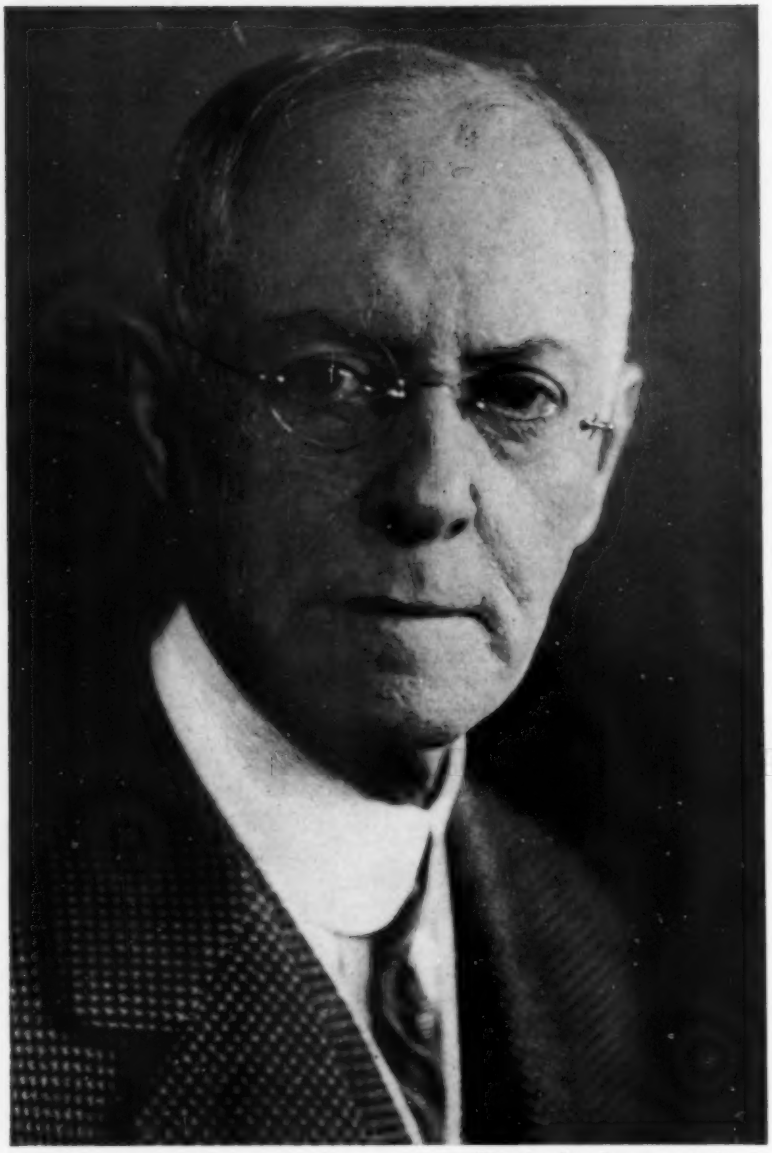
the colon completely enough in a shorter time, even though they feel as if they have eliminated all its contents.

Following the post-evacuation roentgenograms to show the mucous membrane, many patients should be examined during the insufflation of air by rectum. This procedure never ought to be neglected in patients complaining of rectal bleeding, particularly if polyps are suspected. The double contrast study (air following barium) is often the only way that polyps in the colon can be demonstrated.

The choice of roentgenograms to be obtained as a record will depend on the roentgenoscopic findings and the suspected diagnosis. Suffice it to say that "spot" films as indicated during roentgenoscopy and several 14 by 17 inch roentgenograms after the various procedures described above should be made in such a way as to reveal the entire colon unobstructed by overlapping or reduplicated loops of bowel.

From all this it is evident that science and art are intimately blended in this fascinating branch of medicine. Accuracy and care are part of the duty of the physician in every gastrointestinal examination in order that a sound foundation for correct diagnosis be established. Consideration for the patient and the "clinical approach" are the privilege of the physician in radiology as in every other branch of medicine in order that he may play his full part in healing the sick.

Robert P. Barden



Courtesy of the Pennsylvania Gazette

ARTHUR WILLIS GOODSPEED*
1860–1943

ON JUNE 6, 1943, Arthur Willis Goodspeed, a pioneer in the study of x-rays, died at Concord, N. H., a few miles from the small town of Hopkinton where he had been born eighty-three years before. A descendant of early New England settlers, the son of Obed and Helen (Morse) Goodspeed, he passed his early years in Boston. Graduating from the Boston Latin School, he entered Harvard College. Here he came under the influence of John Trowbridge and Benjamin Peirce, who encouraged him to pursue the study of the physical sciences in which he had shown marked aptitude even as a boy. In 1884 he graduated from Harvard,

* Reprinted with permission from *Science*, August 6, 1943, *98*, 125–126.

winning high honors in physics and mathematics.

Immediately after graduation he was offered a position as assistant in physics at the University of Pennsylvania. As this provided an opportunity for advanced study, he accepted it, and his decision determined the scene of his life-work. He enrolled in the newly established graduate school of that university, and in 1889 received the degree of Ph.D., being, incidentally, the first recipient of a degree from that school.

At this time the chair of physics was held by George F. Barker, a scientist of international reputation. Goodspeed's association with this brilliant lecturer gave him invaluable experience and inspiration. He continued under Barker through the grades of instructor and assistant professor, succeeding him when he retired in 1900, and continuing as director of the laboratory until he himself reached the age limit in 1931. Thus, his teaching service of nearly half a century was wholly spent at this one institution.

The period of his service was one of rapid growth of the university and of the department of physics. He saw in his time its staff and its activities increase ten-fold. Much of the success of the many adjustments made necessary by this expansion was due to the administrative skill, ready decision and quiet tact which he exhibited.

As a lecturer he carried on the tradition of his predecessor in sparing no pains to devise ingenious and striking experiments with which to emphasize the essential aspects of his subject. Even after the pressure of administrative duties compelled him to give up much of his formal teaching he would frequently, in presenting new developments in physics, devote great care to illustrate them with clever and interesting demonstrations.

He was early attracted by the scientific aspects of photography—an interest which he retained throughout his life and which perhaps dated from the time when, as a young instructor, he witnessed and assisted at the famous experiments of Muybridge on animal locomotion. What wonder, then, that the report of Röntgen's discovery in 1896 strongly drew his attention and that he became one of the earliest investigators of the new rays? He at once recognized their importance from the medical point of view and, in collaboration with many physicians of the city, carried on numerous investigations on osseous malformations, the location of foreign bodies and similar topics. In this work he developed an experimental technique that was at that time unexcelled. Indeed, some of his plates taken then compare favorably with those of the present day.

His studies of the physical and therapeutic properties of the rays also were begun at this period and carried on for some years. He later investigated the properties of the secondary x-radiation. His work in the field of radiology was recognized by his election in 1902 as president of the American Röntgen Ray Society.

The increase of his official duties put a check to these investigations, though they were never wholly discontinued. The administration of the laboratory and service as chairman of important faculty committees demanded much of his attention. For some years he served on the board of managers of the Franklin Institute. In 1901 he was elected secretary of the American Philosophical Society. His faithful and efficient service in performing the duties of that responsible office will be remembered by many of its members. When he resigned the position in 1935 he was appointed editor of the society's publications and continued as such until a year before his death.

Goodspeed was married in 1896 to Annie H. Bailey, of Hyde Park, Mass. Their children were Frederick, who lost his life in a parachute accident in 1928, Willis and Helen (Mrs. John R. Skeen). In 1913 he married Ethel W. Mitchell, of Staunton, Va. Their son, Arthur, is at present Lieutenant in the armed services of the United States.

Though his professional life was passed in Philadelphia, Goodspeed always retained an affectionate attachment to his New England home. He usually spent his summers at Hopkinton and took part in many of its civic activities. And when his work was finished he returned to his native town to enjoy quietly the close of his life, which was to be so soon terminated.

Goodspeed always retained his sturdy New England characteristics. His thrift and skill in management served him well in the administration for many years of a department which never received adequate financial support. His relations with his associates were most cordial, and he was always solicitous for their interests. The writer will ever hold in memory with pleasure and gratitude the encouragement, advice and cooperation which he received during the many years of their association.

Horace C. Richards

ARTHUR WILLIS GOODSPEED*

In his excellent obituary of Arthur Willis Goodspeed,[1] Horace C. Richards pays tribute to Goodspeed's important pioneer work with x-rays. It is noteworthy that Goodspeed's profound interest in the physical properties of x-rays and in their practical applications was probably due to the fact that he *almost* discovered the phenomenon himself six years before Röntgen. This incident is described in my biography of Wilhelm Conrad Röntgen,[2] from which I quote:

Goodspeed and a friend by the name of W. N. Jennings were photographing electric sparks and brush discharges on the evening of February 22, 1890. After some such experiments had been completed, the table was still littered with loaded plate holders and other apparatus when Goodspeed brought out some Crookes tubes and demonstrated them to Jennings. The next day, Jennings reported that when the plates were developed he had found a very curious phenomenon: two round discs superimposed upon the spark tracings on the photographic negative. No one could explain this curious effect, and the plates were put aside with other freak photographs and were forgotten. Six years later, after the discovery of the roentgen rays had been announced, these negatives were unearthed and reexamined. Another exposure was made with the same apparatus and under similar conditions, and the results were the same; that is, two discs with a sharp boundary on one side and a blurred boundary on the other side were visible on the plate. Goodspeed concluded a lecture on roentgen rays at the University of Pennsylvania on February 22, 1896, with the story of his early experiments, and said: "We can claim no merit for the discovery, for no discovery was made. All we ask is that you remember, gentlemen, that six years ago, day for day, the first picture in the world by cathodic rays was taken in the Physical Laboratory of the University of Pennsylvania."

Before publishing this account an inquiry in regard to the authenticity of the reports of this event brought from Goodspeed the following answer:

Philadelphia, February 15, 1929

. . . The accidental roentgen effect which W. N. Jennings and I produced in 1890 was real and authentic. Because of our laxity in not following the matter up we do not claim any credit whatsoever, but the facts are as stated in such articles as you may have read.

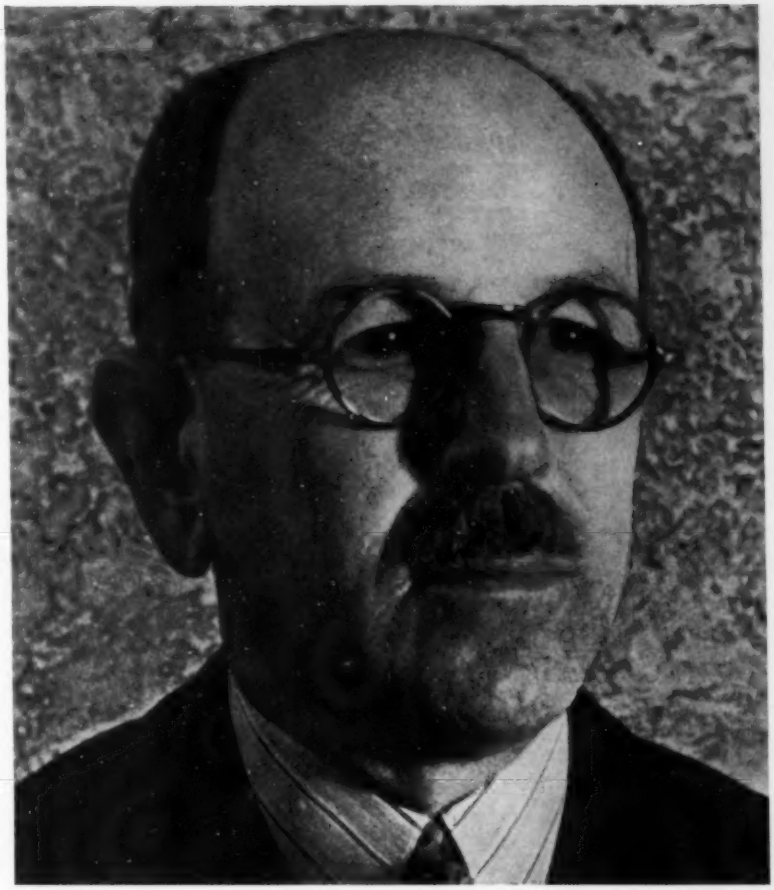
Otto Glasser

Cleveland Clinic Foundation

* Reprinted with permission from *Science*, Sept. 3, 1943, 98, 219.

[1] *Science*, 98: 125, August 6, 1943.

[2] Springfield, Ill., Charles C Thomas, 1934.



LESSER BERNHARDT GROESCHEL

1886–1943

DR. LESSER BERNHARDT GROESCHEL died of coronary occlusion on February 23, 1943. He was Roentgenologist to the Northern Westchester Hospital in Mount Kisco, New York, St. Joseph's and the Professional Hospital in Yonkers, and the Seton Hospital in New York City. His office was in Mount Vernon and he was Associate Roentgenologist to the Mount Vernon Hospital. For a number of years he also had an office in Manhattan. His membership in the American Roentgen Ray Society dates from 1920.

Dr. Groeschel was born August 3, 1886, in Winnesboro, South Carolina. After graduating from the Citadel in Charleston, he attended the College of Physicians and Surgeons, New York City, and was the youngest graduate of the class of 1906. He served an internship in City Hospital, and entered general practice in New York. Very early in his practice he employed the roentgen ray, and he worked in the Department of Roentgenology of Harlem Hospital under Dr. William H. Stewart. After a number of years of general practice, he limited his practice to radiology.

In 1914 he married Miss Susan Bowers Nugent who, with two daughters, Mrs. Alexander Watson Baird and Courtney, survives him.

RAMSAY SPILLMAN

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual Meeting: 1943, cancelled.

American College of Radiology
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: 1943, cancelled.

Arkansas Radiological Society
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Drake Hotel, Chicago, Ill., Executive Sessions only, Dec. 1–2, 1943.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Section on Radiology, California Medical Association
Secretary, Dr. J. D. Coate, 434 Thirtieth St., Oakland, Calif.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

Radiological Section, Los Angeles County Medical Association
Secretary, Dr. Donald R. Laing, 65 North Madison Ave., Pasadena, Calif. Meets on second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

Chicago Roentgen Society
Secretary, Dr. Warren W. Furey, 6844 S. Oglesby Ave., Chicago, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. J. O. Newton, 13921 Terrace Rd., East Cleveland. Meets at 6:30 P.M. at Midday Club on fourth Monday each month, October to April, inclusive.

Denver Radiological Club
Secretary, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Building.

Florida Radiological Society
Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Michigan Association of Roentgenologists
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Hugh F. Hare, Lahey Clinic, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. H. J. Perlberg, 921 Bergen Ave., Jersey City. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

New York Roentgen Society
Secretary, Dr. H. H. Kasabach, Presbyterian Hospital, New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

North Dakota Radiological Society
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Ohio Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. R. G. Alley, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Sidney Larson, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

St. Louis Society of Radiologists
Secretary, Dr. P. C. Schnoebelen, 462 N. Taylor Ave. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. H. A. Hill, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months at Toland Hall, second at Lane Hall.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. Herman Klapproth, Sherman, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October throughMay, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets monthly on third Thursday from November to June inclusive, at 8:15 P.M., 32 Welbeck St., London.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Continental Europe

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

PRACTICE OF RADIOLOGY AND HOSPITAL SERVICE PLANS*

Among the problems especially considered by the House of Delegates at the meeting of the American Medical Association in Chicago in June, few have aroused more interest or concern than the place of radiology in new forms of hospitalization insurance as well as its place in routine hospital service. The question was brought before the House as a result of three resolutions introduced at the Atlantic City session in 1942. These resolutions were referred to the Board of Trustees for clarification as to existing relations between physicians and hospitals. The supplementary report of the Board of Trustees pointed out that all the questions involved in the same or similar form had previously been considered and acted on by the House of Delegates. Specific citations were made to the previous actions of the House on this subject.

The reports were assigned by the speaker of the House of Delegates to the Reference Committee on Reports of Board of Trustees and Secretary. The reference committee, after reviewing the two supplementary reports of the Board of Trustees, made the following recommendations:

A. That the House emphatically reiterate that it disapproves the injecting of a third party into the personal relationship of the patient and the physician, and that hospitals should not be permitted to practice medicine.

B. That the practice of radiology, pathology and anesthesiology is the practice of medicine just as much as is the practice of surgery or internal medicine, and that it is only a short step from including the first three in a medical service plan to including the whole field of medicine in such a plan.

C. That the public should be educated to realize that the hospital created monopoly control of radiologic or any service as a source of profit beyond the normal provision for replacement, department development and proper proportion of over-all costs of operation of the hospital should not be permitted, nor can the hospital rightfully use per diem charges against all the hospital patients to support a radiologic or other department devoted to creating bargains in radiologic or other services in order to make hospital group insurance more attractive. To permit either will result in decrease of the quality of service and increased cost to the patient.

D. The medical profession must watch with care all proposed plans for medical service and endeavor to prevent the acceptance of any plan which includes medical service under the control of the hospital.

E. The effectiveness of this program can be attained only if constituent state medical associations and component county medical societies use their influence on hospitals in their respective localities and exercise control over the local members of the medical profession.

F. The public must be educated on what it will mean to them in the way of inferior medical care if these dangerous trends are not curbed.

G. In the relationships of the medical staff and the board of directors of a hospital there should be no intermediary. The staff should have direct access to the board.

H. The Board of Trustees should continue its conferences with national hospital associations and should also endeavor to enlist the support of special medical organizations in education both of the profession and of the public.

The Board of Trustees in general and Dr. Sensenich and Dr. Irons in particular should be commended for the tremendous amount of time and effort which they have given in preparing their very informative report.

Your reference committee recommends that the House of Delegates of the American Medical Association urge the American Hospital Association to withhold approval of the uniform comprehensive Blue Cross contract proposed by the Hospital Service Plan Commission of the American Hospital Association which includes certain medical services as a part of hospital care and which, if adopted as recommended by the said commission, would virtually compel the addition of medical services to the benefits of those Blue Cross plans and now accede to the demands of the American Medical Association by confining their benefits to hospital services.

In presenting this report to the House of Delegates, Dr. Louis H. Bauer, the chairman of the reference committee, made some interesting comments which should be considered carefully by every physician.

* An editorial reprinted with permission from the *Journal of the American Medical Association*, July 31, 1943, *122*, 948–949.

These supplementary reports of the Board of Trustees present an analysis of current trends in the nature of medical practice which may have a profound effect on the whole future of medical service. The reference committee said:

> Unless the medical profession as a whole is willing to devote at least the same amount of time and effort in studying the report and correcting the dangers pointed out therein as the Board of Trustees has in compiling it, then we might as well "throw in the sponge" now and consent to lay domination of the practice of medicine.

In the report of the reference committee it was indicated that the "Blue Cross" plans to give medical service with or without the approval of the medical profession. This prediction has already been demonstrated to be a practice in many parts of the country. An announcement just made by the Associated Hospital Plan in New York City states plainly the intention and the conditions under which services will be rendered. The report of the reference committee recognizes the bald outlines of the situation when it says "The fact that the House of Delegates on numerous occasions has declared against the selling of medical service by hospitals has not stopped the practice." The treatment recommended for the cure of this unfortunate situation is also succinctly stated by the reference committee when it says "National approval or disapproval of any practice is a waste of time unless the state and county organizations will see that the dicta of the national body are carried out in the small localities."

The majority of roentgenologists of the United States and their national organizations are convinced that the subscribers' contract in hospitalization insurance should exclude all medical services and that contract provision should be limited exclusively to hospital facilities. The action of the House of Delegates taken in 1934 emphasized that all features of medical service in any method of medical practice should be under the control of the medical profession and that hospital service and medical service should be considered separately. Again in 1936 the House of Delegates emphasized its interpretation of this point of view by saying, in accepting the report of a reference committee:

> If hospital service is limited to include only hospital room accommodations, such as bed, board, operating room, medicines, surgical dressings and general nursing care, the distinction between hospital service and medical service will be clear.

In the report of the reference committee this year, this point is further stressed in paragraphs C, D and G, cited in this editorial. These paragraphs indicate the technics by which those who are concerned may aid in reversing or inhibiting a trend which is apparently now well under way in regard to radiologic practice. Education of the public as to the significance of radiologic practice is important in this direction. Doubtless few of those who obtain the services of radiology in hospitals realize that in many institutions the radiologist is working for a small salary and the hospital is deriving a considerable profit from his professional practice. In other institutions what amounts to virtual fee splitting between the hospital and the radiologist is routine technic. Certainly it is not to the interest of the patient, who must be given first consideration, that the necessity for radiologic study of his case should be made the occasion for providing excess income for the hospital. If the trend is to be controlled, every new arrangement between a hospital and a radiologist and every new plan for a prepaid medical service should be carefully scanned by the county medical society in the area concerned to determine whether or not it violates the fundamental tenets that have been so often iterated and reiterated by the House of Delegates of the American Medical Association. The danger to the sick does not lie in the collection of income for the hospital or the radiologist; it is in the inevitable deterioration that must come in any form of medical service when its practitioners are placed on a basis in which the quality of the service rendered is secondary to the price charged or the method by which the service is supplied.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

THE ELECTROCARDIOGRAM AND X-RAY CONFIGURATION OF THE HEART. By Arthur M. Master, B.S., M.D., F.A.C.P., Cardiologist to the Mt. Sinai Hospital, New York; Assistant Professor of Clinical Medicine, Columbia University, New York. Second edition, enlarged and thoroughly revised. Cloth. Price, $7.50. Pp. 404, with 163 illustrations. Philadelphia: Lea & Febiger, 1942.

This volume is based on the thesis that there is a close correlation between the form of the electrocardiogram and the size, shape, and position of the heart as determined by roentgenographic studies including visualization of the individual cardiac chambers following the injection of diodrast. Approximately one hundred pages are devoted to the variations in the normal cardiac silhouette and the normal electrocardiogram with age, body habitus, degree of obesity, respiration, posture and pregnancy. The effect of fixation of the mediastinum upon the alterations of the electrocardiogram produced by changes in posture is also discussed. This section is a valuable one.

The discussion of the changes in the electrocardiogram and the roentgenographic outline of the heart produced by hypertension and valvular heart disease occupies considerably more than one hundred pages, and includes numerous case histories. Among the many interesting illustrations is a reproduction of a series of electrocardiograms showing the gradual development, over a period of seventeen years, of left axis deviation and inversion of T_1 in a case of hypertensive heart disease. Several cases of giant left auricle are presented. In the historical review at the beginning of this section (page 112) it is stated that "Einthoven and his co-workers suggested that rotation of the heart, rather than enlargement to the left, was the cause of inversion of the QRS group in lead III in hypertrophy of the left ventricle," and that "they believed that rotation of the heart about a sagittal axis might produce signs indistinguishable from those of ventricular hypertrophy." The reviewer can find no authority for these statements in the article cited. On the contrary, he finds there the conclusion that the great rotation of the electrical axis sometimes observed in left ventricular hypertrophy must be due to changes in the spread of the excitatory process and the course of the contraction wave.

Master apparently believes that the left axis deviation and inversion of the T wave in lead I commonly associated with hypertensive heart disease and with aortic valve lesions are both due either to increased thickness of the left ventricular wall, to lengthening of the subdivisions of the left branch of the His bundle, to the effect of left ventricular enlargement upon the position of the heart, or to a combination of all three. Because he has not expressed them with sufficient care the exact nature of his concepts is not easy to ascertain. He writes (pages 114 and 115): "It has been shown that the anatomical configuration of the cardiac chambers, in relation to each other and to the chest as a whole, are the prime factors in the production of the type of electrocardiogram that is being described, and not the condition of the heart muscle." To this ungrammatical and obscure statement he presently adds the following: "The author believes that the changed anatomical configuration of the muscle masses may alter the time of onset or regression of the electrical excitation wave in specific tissues like the bundle branches or in the myocardium itself, and thus may produce characteristic electrocardiograms in the standard leads. Furthermore, as the left ventricle becomes hypertrophied, a rotational effect of the heart may be produced, thus disturbing the electrical relationship of the two ventricles." The reviewer ascribes the lack of clarity to carelessness rather than to an intention to be vague and non-committal. Statements, similar to those quoted, with reference to the origin of right axis deviation and inversion of the T wave in leads II and III in association with preponderant enlargement of the right ventricle (page 150) are considerably less inscrutable, but still leave much to be desired in the way of lucidity.

The author may be right in believing that the inversion of T_1 associated with left axis

deviation in cases of enlargement of the left ventricle is usually due to late activation of the epicardial surface of this chamber, and not to coronary disease or insufficiency or to degenerative, sclerotic, or inflammatory foci in the myocardium. It should, however, be noted that, as Barnes has pointed out, the inversion of T_1 in hypertensive heart disease may disappear even though the associated alterations of the QRS complex persist unchanged. The reviewer cannot support the contention that the ability of some patients, with enlargement of the left ventricle and electrocardiographic abnormalities of the kind in question, to engage in strenuous physical exertion (see page 138) excludes the presence of myocardial damage. Many myocardial disorders are compatible with a good exercise tolerance.

In the discussion of his cases Master does not always clearly distinguish between those electrocardiograms that are within normal limits and those that are not. As a consequence there is considerable danger that readers with little electrocardiographic experience may get the impression that the occurrence of slight left or slight right axis deviation in cases in which other data point to the presence of a valve lesion has important diagnostic significance. The percentage of cases in which the electrocardiogram furnishes unequivocal evidence of a valve lesion that cannot be more readily detected by physical or roentgenographic examination is very small. The correlation between the inclination of the electrical axis and the relative weight or relative size of the two ventricles is by no means as close as the author's discussions of his cases might lead one to suppose.

On pages 110 and 158 it is stated, with reference to Einthoven's equilateral triangle, that the vector which portrays the cardiac electromotive force represents the electrical current. By convention this vector is so drawn that it points away from the negative and toward the positive pole; the current flows in the opposite direction.

The section on congenital heart disease presents data on a series of very interesting cases; the discussion is similar in character and scope to that which deals with hypertensive heart disease and with acquired valve lesions. The same may be said of the material pertaining to the heart in Graves' disease, in myxedema, in pericarditis, in asthma, emphysema and pulmonary fibrosis, in pulmonary embolism, in pneumothorax, and in deformities of the chest.

The reviewer feels that the brief chapter on bundle branch block and ventricular hypertrophy contains a good deal of misinformation. Anyone who depends, in the differentiation of right from left bundle branch block, exclusively or even mainly upon the degree or kind of axis deviation present will make a great many errors. It is true that in lesions of the aortic valve left branch block is more common than right, and that in mitral stenosis and congenital heart disease the opposite is the case. It is also true that transient right bundle branch block occurs in pulmonary embolism. Nevertheless, both right and left branch block are relatively rare in these conditions in comparison with their frequency in arteriosclerotic heart disease. On the basis of present day clinical and experimental data there is no justification for the belief that the electrocardiograms held to represent human bundle branch block are often a consequence of any lesion or lesions other than a localized conduction defect involving one of the two main subdivisions of the His bundle. It is not true that the electrocardiographic pattern produced by left ventricular enlargement and that which represents left branch block are similar in all respects except the length of the QRS interval, nor is there any good evidence that these two types of electrocardiograms are alike in origin.

In the opinion of the reviewer the electrocardiographic pattern ascribed by the author to acute coronary insufficiency is not sufficiently distinctive to have any important diagnostic value. The remainder of the section on the heart in acute disease requires no comment.

In conclusion, it may be said that this book is beautifully illustrated and contains many very interesting case histories. The clinical syndromes and the changes in the roentgenographic appearance of the heart in the cardiac conditions covered are well described. Valuable electrocardiographic data are presented, but Master's study deals primarily with those types of heart disease in which the electrocardiogram has least to offer as an aid in accurate diagnosis. The discussion which deals with the fundamentals of electrocardiography and with the interpretation of the electrocardiogram leaves much to be desired, and is likely to mislead readers who have not had considerable experience in this field.

FRANK N. WILSON

PLASTIC SURGERY OF THE BREAST AND ABDOMINAL WALL. By Max Thorek, M.D., LL.D., F.I.C.S., F.I.C.A., K.L.H. (France); K.C.I.; C.O. St. Alex; Medal of Hon. Rep. of Venezuela; Professor of Surgery, Cook County Graduate School of Medicine; Attending Surgeon, Cook County Hospital; Consulting Surgeon, Municipal Tuberculosis Sanitarium, Chicago; Surgeon-in-Chief, American Hospital of Chicago, etc. With an Introduction by Rudolf Nissen, M.D., F.I.C.S., Formerly Associate Professor of Surgery of the University of Berlin, and Professor and Head of the Department of Surgery of the Medical University of Istanbul, Turkey; With a Foreword by J. Eastman Sheehan, M.D., F.A.C.S., Professor of Plastic Reparative Surgery, New York Polyclinic; Surgeon, Morrisania City Hospital, New York; Associate Surgeon and Lecturer, International Clinic, Lariboisiére Hospital, Paris, France. Cloth. Price, $16.50. Pp. 446, with 458 illustrations. Springfield, Illinois: Charles C Thomas, 1942.

"In the business and social world, the individual afflicted with abnormal states of the breasts or abdominal wall is seriously handicapped, in some instances to the point of desperation—to say nothing of the somatic and psychic effects which may develop from their long continued existence. These are in many instances as troublesome to the patient as are congenital or acquired defects in other portions of the body. The need for scientific reconstructive surgery to remedy these handicaps is therefore evident."

Max Thorek, in his 446 page book, has compiled a comprehensive treatise of this particular phase of reconstructive surgery which will prove of interest to those dealing with this perhaps unusual but definite human need.

Detailed anatomical considerations of the female breast are recorded pictorially with the author's artistic and well known prints. It is clearly Thorek's hope to awaken in the minds of the medical profession a realization that the suggestive powers of the breast, with its unusual physical and psychic attributes, are more important to woman than its functions as an organ.

"Today art emphasizes the breasts by depicting them full, firm, and upright, with erect nipples saucily indicated. And it employs the breast to indicate sex appeal above all else. The breasts displayed in today's art are the breasts woman seeks to possess. She seeks to possess them because in them she recognizes the qualities that would provoke the male interest and desire she wishes to arouse. . . . women look to plastic surgery and see in it a hope for a solution."

It may be questionable in the mind of the reader as to whether the views of the artist will necessarily coincide with the somewhat less philosophical views of the surgeon in this connection.

The chapters dealing with history, folklore and racial characteristics of the female breast provide interesting reading. In the Caucasian race the female breast is usually hemispherical, while in the Negro races it is conical or pointed. Following puberty the breast gradually descends somewhat and assumes various degrees of pendulosity, in the colored races particularly, Negroes find pendulosity of the breast convenient for nursing their young ones, which they carry on their backs. The breast is simply projected over the shoulder or slipped through the arm pit to the infant!

Various technical procedures for plastic operations upon the breast are presented in detail. The author's operation utilizes free transplantation of the nipple with removal of the hypertrophied or prolapsed glandular tissue from the inferior aspect of the breast. He feels that this operation is applicable to every form and size of breast and that the esthetic results are, as a rule, excellent. Lactation rarely occurs subsequent to plastic operations upon the breast. The last chapter of the book deals with plastic operations for pendulous abdomen.

The title of the book may be misleading as it might be construed to include hernioplasty and plastic procedures designed to cover the thoracic wall after mutilating operations. The book will be of interest to and valuable for those surgeons who are concerned with problems, psychological and surgical of unattractive or annoying breasts in women.

FREDERICK A. COLLER

THE PERIODICITY AND CAUSE OF CANCER, LEUKAEMIA AND ALLIED TUMOURS: WITH CHAPTERS ON THEIR TREATMENT. By J. H. Douglas Webster, M.D., F.R.C.P.E., F.F.R., Honorary Director, Meyerstein Institute of Radiotherapy, Middlesex Hospital, London; Lecturer and Examiner in Radiology, University of London; Examiner in Radio-

therapy, Faculty of Radiologists, London, etc. Cloth. Price, $3.50. Pp. 178, with 5 plates. London: Baillière, Tindall and Cox; Baltimore: Williams & Wilkins Co., 1940.

The author has written this small volume in an effort to prove two points: first, that the growth of all cancers and some benign tumors occurs in definite cycles (usually thirty-three weeks or multiples thereof), and second, that the real cause of most malignant tumors is a virus.

Both Bland-Sutton and Alfred Pearce Gould believed that cancer showed periods of quiescence, followed by periods of rejuvenescence, and statistical data gathered from the study of 600 cases is used to establish the theory of rhythmic tumor growth. However, the evidence presented leaves the reviewer unconvinced that all neoplasms obey such a precise plan of behavior. The contention that the causative virus can be visualized in sections viewed microscopically seems even less acceptable, and the chapters devoted to etiology will hardly receive the endorsement of most American oncologists. Nevertheless, the rhythmic growth theory is of sufficient interest to render the book well worth reading.

Charles L. Martin

The Injured Back and Its Treatment. Edited by John D. Ellis, M.D. Cloth. Price, $5.50. Pp. 377, with numerous illustrations. Springfield, Illinois: Charles C Thomas, 1940.

Ellis is to be congratulated for editing this excellently arranged symposium on the injured back and its treatment. The selection of coauthors is a particularly happy one, resultant in authoritative presentation of various phases of the problem of the low back which are essential for a well balanced conception.

The chapter by Sir Arthur Keith on "Man's Posture—Notes on its Evolution" is particularly of value to clinicians clarifying the modern conception of the evolutionary phases of human posture.

Nathan S. Davis has prepared a most interesting chapter on "Backache, a Symptom of Visceral Disease." The fundamental features of reflex symptomatology are excellently described from an obviously broad acquaintance with experimental and clinical findings. An excellent bibliography follows the chapter.

The remaining chapters are well prepared comprehensive clinical presentations which cover the problem of injuries to the back.

Frequent quotations from the more recent publications correlate their presentations with the literature of today which is an essentially important feature of this book.

An extensive bibliography is presented.

The book is an authoritative document representing the best thought of today on the problem of the injured back. Thomas has maintained his usual high standard of publication. The illustrations are excellently reproduced. We highly recommend this volume.

Carl E. Badgley

Infantile Paralysis: A Symposium Delivered at Vanderbilt University, April, 1941. Cloth. Price, $1.25. Pp. 239, with illustrations. New York: National Foundation for Infantile Paralysis, Inc., 1941.

This book published by Waverly Press for the National Foundation for Infantile Paralysis presents six lectures prepared by outstanding authorities in their various fields, dealing with the History of Poliomyelitis, the Etiology, the Immunological and Serological Phenomena, Pathology and Pathogenesis, Epidemiology and lastly, Treatment and Rehabilitation. An extensive bibliography of 575 references is appended.

This is an authoritative review of the six features of poliomyelitis thoroughly discussed giving the reader the progress of knowledge on these subjects to the time of the publication.

We recommend it as a basic book full of important information on the fundamental features of infantile paralysis.

Carl E. Badgley

DEPARTMENT OF TECHNIQUE

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LOCALIZATION OF FOREIGN BODIES WITH THE ROENTGENOSCOPE

By BASIL THOMPSON, M.D.

WASHINGTON, D. C.

TO LOCALIZE radiopaque bodies, the following simple but fairly accurate procedure, previously described,[1] is amended and simplified herewith.

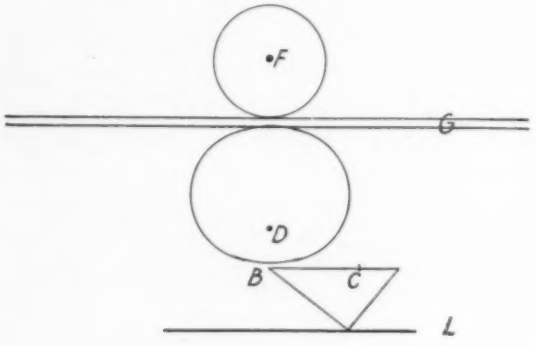

Fig. 1

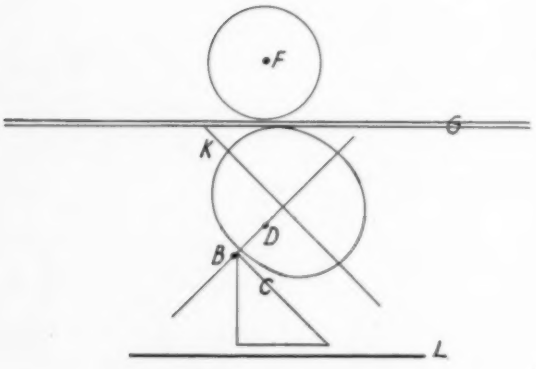

Fig. 2

Figs. 1 and 2. Fig. 1. First position. Fig. 2. Second position. *G*, roentgenoscope stand; *F*, roentgen tube; *L*, fluorescent screen; *R*, rule containing fixed marker (*B*) and sliding marker (*C*); *K*, angle of rotation for second observation; *D*, foreign body.

[1] Thompson, B. Localization of foreign bodies with the roentgenoscope. Am. J. Roentgenol. & Rad. Therapy, 1934, *32*, 412–413.

This method constitutes the viewing of the shadow of the foreign body through the tissues from two directions, and hence, by a simple application of triangulation, of estimating its depth from the surface at any point.

The necessary apparatus consists of a roentgenoscope of any type, a rule of wood or other transparent material, from 4 to 6 inches in length, forming the hypotenuse of a right-angled isosceles triangle with sides of the same material, two short pieces of wire, a strip of adhesive tape and iodine or marking ink.

One piece of wire is looped securely about the shaft of the rule over the zero mark on the scale, to constitute a fixed marker. The other piece is looped loosely around the rule in such a manner that it may slide along the shaft to form a sliding marker.

Figures 1 and 2 illustrate the two successive positions of viewing the foreign body.

In the first position shown in Figure 1, the shadow of the foreign body is viewed on the fluorescent screen, and the rule, *R*, is so placed that the shadow of the fixed marker, *B*, is superimposed on the shadow of the foreign body, *D*. The rule is then fastened securely to the body surface by means of an adhesive strip across its shaft, at the location of the fixed marker, *B*, so the unsecured end of the rule containing the sliding marker, *C*, projects at right angles to the line of view in the first position in a direction opposite to that in which the body or member may be rotated for the second observation.

The body or member is then rotated through an angle of 45 degrees (with the fluorescent screen now placed parallel to the distal arm of the rule) and the shadow of the foreign body is again viewed on the fluorescent screen. The sliding marker, *C*, is manipulated along the shaft of the rule until its shadow is superimposed on the shadow of the foreign body.

The distance of the sliding marker, *C*, from the fixed marker, *B*, equals the depth of the foreign body from the surface at the point of the fixed marker, and may be read directly from the scale on the rule.

This method may be utilized to localize foreign bodies, particularly bullets and shrapnel. A series of measurements from different points on the body surface is of value in determining the best method of surgical approach. To any unit equipped for roentgenoscopy this method probably possesses advantages of simplicity in use and transportation.*

2901 Sixteenth St., N.W.
Washington, D. C.

* It is the information of the author that the method outlined above has been almost universally used in the Japanese Army Medical Corps since 1937. Further data in this respect will be appreciated by the author.

A DEVICE TO AID IN THE PROCESSING OF DENTAL ROENTGENOGRAMS*

By E. E. BEOHM, A.B.
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THE accompanying photograph (Fig. 1) shows an arrangement which we made about five years ago to hold dental films after they have been exposed so that they can easily be placed on the developing hanger in the proper sequence. It has

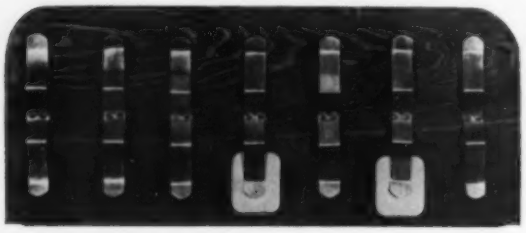

FIG. 1

proved very helpful and the idea is therefore passed on with the hope that others may find it useful.

The device consists essentially of a board on which are fastened two rows of clips, which correspond to that of the developing hanger. These clips are best made of strips of spring brass, which are fastened to the board by two screws in the center of the strip so that each strip thus becomes a holder for two films, one above and one below. If spring brass is not available, an old clock spring makes a very good substitute. If this is used the spring is cut off in sections of the proper length, the center heated and drilled for screws and then fastened to a board with the concavity of the spring down. The ends should be heated and turned up slightly.

In use we put the film taken of the patient's left upper third molar region under the top left clip on the board, and continue along the upper row of clips so that the patient's right upper third molar film is under the last clip on the right at the top of the board. Then starting at the bottom left clip with the patient's left lower tooth, the lower row is filled in a similar manner to the upper. When only one or a few films are taken, the film or films are placed under the appropriate clips. When the device filled with exposed films is taken to the dark room the films are taken from the board one at a time and placed on the developing hanger in the same order as they occur on the board. The board is of $\frac{1}{2}$-inch material, 14 inches long by 6 inches wide. The top corners of the board are rounded in order that there will be no chance of turning the board around and so confusing the order of the films on the holder. The slips are $\frac{3}{8}$ inch by 4 inch brass strips.

* From the X-Ray Department of The Myers Clinic, Philippi, West Virginia.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Meng, C. M., and Wu, Y. K. Tuberculosis of the flat bones of the vault of the skull; a study of forty cases. *J. Bone & Joint Surg.*, April, 1942, *24*, 341–353.

In this paper 40 cases of tuberculosis of the skull are analyzed and the clinicopathological aspects of the disease are discussed. Tuberculosis of the skull is not rare in parts of the world where tuberculosis is prevalent. It is an affection predominantly of childhood and adolescence. It is practically always secondary to active or latent tuberculosis elsewhere in the body. It is frequently associated with pulmonary lesions and those of bones and joints. Not infrequently tuberculosis of other flat bones may coexist in the same individual.

Two types of lesions are described, the circumscribed (perforating) type and the diffuse (infiltrating) type. The circumscribed type is more frequently found and is often represented clinically by a painless cold abscess or discharging sinus.

Although roentgenography is an important aid in the diagnosis of lesions of the skull, it occasionally fails to disclose early, superficial, periosteal tuberculous lesions. On the other hand, the visualization of actual lesions by roentgenograms does not mean necessarily that they are tuberculous. The findings are often so varied and confusing that an incorrect diagnosis can easily be made. The usual roentgenographic picture is that of one or more circumscribed, round or oval, punched-out bone defects, in which a definite sequestrum or bone sand may be observed, and about which there may be no reaction, or a zone of increased density extending from 1 to 2 cm. peripherally. Tuberculosis of the skull is predominantly a destructive lesion, which shows little evidence of osteoblastic repair. Occasionally, however, exuberant osteogenesis may be observed along with osteolytic changes in cases in which multiple discharging sinuses or ulcerative wounds of the scalp are present. In some cases instead of the well defined defects, the lesions may appear irregular in shape, less distinct in outline, and of fairly large size.

A cure can be reasonably hoped for in selected cases, if local excision is carried out, but in the majority of cases the condition is so far advanced that treatment consists of simple local dressings. In a few cases, high voltage roentgen therapy proved to be beneficial.—*R. S. Bromer.*

Martin, Hayes. Tumors of the palate (benign and malignant). *Arch. Surg.*, April, 1942, *44*, 599–635.

Malignant tumors of the palate, excluding benign mixed tumors, constitute about 8 per cent of all oral cancer, about 5 per cent of all cancer of the upper respiratory and alimentary tracts and about 2 per cent of all human cancer. The proportion of malignant tumors to benign mixed growths of the palate is 12 to 1.

The author discusses a group of 103 cases of benign and malignant tumors of the palate. The average age of all the patients was fifty-seven years, that of the patients with epidermoid carcinoma sixty-one years, of those with adenocarcinoma forty-eight years and those with benign mixed tumors thirty-seven years; that is, epidermoid carcinoma of the palate is a disease of old age while adenoid tumors generally occur before the age of forty-five.

The epidermoid carcinomas grow rapidly as compared with the adenoid group, which includes the adenocarcinomas and the benign mixed tumors. The adenoid tumors grow slowly and are non-infiltrative and capsulated. The average duration of life from the beginning of symptoms in the fatal cases of epidermoid carcinoma was one and a half years, in fatal cases of adenocarcinoma five years. Epidermoid carcinoma metastasizes much more freely than adenocarcinoma. Mistaken diagnosis is made in about 25 per cent of these tumors when they first apply for examination and they are given local treatment.

Treatment depends on the histopathological nature of the tumor and whether it is in the hard or soft palate. The treatment of adenocarcinoma and benign mixed tumors is preferably by surgical removal. Epidermoid carcinoma of the soft palate is very radiosensitive and should be

treated by irradiation but on account of the danger of injury of the bone these tumors in the hard palate should be treated by surgery or a combination of surgery and irradiation.

The best method of surgical removal of tumors of the palate is by the actual cautery. In radiation treatment a daily dose of 300 to 400 r is given up to a total of 7,000 to 8,000 r if high voltage (200 to 250 kv.) is used or up to 12,000 to 14,000 r if low voltage (100 to 120 kv.) is used. When the growths are on the surface the shortest possible target-skin distance should be used (15 to 25 cm.). If all the tumor cannot be reached by intraoral treatment, additional irradiation should be given through the skin of the cheeks. External irradiation should often be supplemented by the interstitial use of radon seeds. The usual complications of pain, radionecrosis and osteomyelitis and hemorrhage occur when excessive doses of radiation break down normal as well as tumor tissue.

The five year cure rate among the 93 malignant cases in this group was 18, or 23 per cent. It was twice as large for the adenocarcinomas (40 per cent) as for the epidermoid carcinomas (19 per cent). All the benign mixed tumors were cured.—*Audrey G. Morgan.*

NECK AND CHEST

Martin, Robert C. Atlas-axis dislocation following cervical infection. *J. Am. M. Ass.*, March 14, 1942, *118*, 874–875.

Dislocation of the axis on the atlas is often traumatic but it may also occur as a sequel to cervical infections.

There are three articulations: the lateral ones are arthrodial diarthroses because of the flattened articulating surfaces; the third, a rotary diarthrosis, median in position, lies between the smooth anterior surface of the odontoid process and the articular facet on the posterior aspect of the anterior arch of the atlas.

Grieg showed that cervical infections, by producing hyperemia, cause vertebral decalcification of a greater or less degree. If the bone has undergone previous decalcification the ligaments yield readily. Then there may occur a slipping forward of one or both lateral articular facets of the atlas and locking as the facet slips forward and downward over the opposing facet of the axis or a slipping backward of one articular facet of the atlas.

The patient holds his head rigidly, slightly in front of the normal plane, tilted toward one shoulder, with the face rotated toward the opposite shoulder.

Reduction of the dislocation is accomplished by accentuating the deformity, in addition to traction, permitting unlocking of the lips of the lateral articular facets. Reposition of the vertebrae is secured by extension and by bringing the head to the midline while rotating the chin to its normal position. The author presents a series of 4 cases, each case having features of its own. All were in children. Recovery followed reduction of the dislocation and traction.—*S. G. Henderson.*

Hess, Julius H., Abelson, S. M., and Bronstein, I. P. Spontaneous atlantoaxial dislocations; possible relation to deformity of spine. *Am. J. Dis. Child.*, July, 1942, *64*, 51–54.

In 1935 the authors called attention to spontaneous atlantoaxial dislocations occurring in childhood. They felt that these dislocations were all rotary and unilateral. Evidence was adduced to show that the odontoid process was the pivotal point and that the transverse ligament remained intact. The absence of symptoms referable to the spinal cord was emphasized because there is no reduction in size of the spinal canal and consequently no encroachment on the cord. They also suggested the importance of prophylactic measures in the management of suppurative conditions about the head and neck in order to avoid this complication and laid stress on repeated roentgenograms to visualize the joint. They quote Jostes who pointed out the limitations of ordinary roentgenography and the aid the laminagraph can give in the visualization of the occipitoatlantic and atlantoaxial joints.

The case they present in this paper is that of a boy first seen when twelve years of age. There was no history of trauma. Reduction was urged but his parents failed to follow the advice. He was put in the care of a chiropractor who made no actual attempt at reduction. Massage, diathermy and exercises were also used. Five years later the parents thought he had outgrown his crooked neck deformity, but the authors' examination revealed otherwise. No subjective symptoms were present and the boy was seemingly in good health. They emphasize the necessity of reduction. Further reports of a greater number of cases with follow-up studies will determine the method of treatment most likely

to produce a functionally normal joint and absence of facial asymmetry, wryneck and compensatory scoliosis.—*R. S. Bromer.*

Blumenthal, Sidney, and Davis, David B. Coarctation of the aorta in childhood; report of two cases in which the diagnosis was confirmed by the intravenous injection of diodrast. *Am. J. Dis. Child.*, Dec., 1941, *62*, 1225–1232.

Bonnet, quoted by the authors, divided coarctation of the aorta on the basis of the anatomic lesions into the so-called infantile and adult types. In the infantile type, the coarctation characteristically occurs between the origin of the left subclavian artery and the mouth of the ductus arteriosus. The anomaly may be noted as diffuse narrowing of the isthmus of the aorta, the presence of a mere fibrous cord or the complete absence of the isthmus. The adult type of coarctation is characterized by stenosis of the aorta occurring at or just distal to the insertion of the ductus arteriosus. The ductus is usually obliterated. In the infantile type the ductus is usually patent, its size being inversely proportional to the lumen of the isthmus, so that in the presence of complete obliteration of the isthmus the ductus may be markedly dilated and continue to anastomose with the descending aorta. The infantile type is frequently associated with other marked developmental abnormalities of the cardiovascular system and therefore is usually incompatible with life. The adult type is not associated with other severe congenital cardiovascular defects and is characterized by the development of an adequate collateral circulation. An extensive anastomosis develops between branches of the subclavian and aortic intercostal arteries, as well as between the epigastric and internal mammary artery. Because of this collateral circulation the adult type is usually compatible with long life, and the case of a patient ninety-two years of age has been reported. The authors make the suggestion that the terms "compensating" and "noncompensating" be substituted for "adult" and "infantile" type of coarctation.

Two cases are reported in this paper in which the diagnosis was made during childhood. Blumenthal and Davis review the diagnostic criteria, and in the second case, using the method of intravenous injection of a contrast medium, the presence of the coarctation and the collateral circulation was demonstrated. The roentgenograms showed a narrowing of the aorta at the junction of the arch and the descending portion. The opaque material was seen to be thrust against this narrowed segment, but little passed through. Most of the opaque material passed into the brachocephalic vessels. There was definite visualization of the internal mammary artery, which was moderately dilated. The left ventricle was also moderately dilated.

In cases of coarctation of the aorta ordinary roentgenograms of the heart are of no value since the size and contour are within normal limits. One may observe, however, the presence of erosion of the ribs, caused by the enlarged and tortuous intercostal arteries. Such erosion evidently takes several years to develop and is therefore seen much more constantly in adults than in children although it has been noted in children as young as five years of age. In both cases reported in this paper the roentgenograms of the heart and ribs revealed no abnormalities. —*R. S. Bromer.*

Blatt, Maurice L., and Zeldes, Mary. Ectopia cordis; report of a case and review of the literature. *Am. J. Dis. Child.*, March, 1942, *63*, 515–529.

A case of ectopia cordis is reported. This condition has been defined by Maude Abbott as "a displacement so that the heart passes out of the thorax and comes to lie either upon the outer surface of the body or in the abdominal cavity."

The roentgen examination of the infant patient of the authors showed a large oval prominence in the upper abdominal region due to a congenital ventral hernia. This contained shadows indicative of gas in the intestines. The sternum in the lateral projection was widely separated from the anterior ends of the ribs. The pulmonary fields were clear. The usual intrathoracic cardiac space was occupied by a very thin shadow, much more prominent on the right than the left, which did not pulsate on roentgenoscopic examination. It was thought that the hernial sac contained small bowel, a portion of the duodenum, pylorus, a portion of the liver and a major portion of the cardiac structure. The shadow present in the usual cardiac position was accounted for partially on the basis of thymus shadow and remaining pericardial attachments. At autopsy the heart was found to be much elongated. The abdomi-

nal mass contained the heart, a portion of the liver, the cecum, the appendix, the ileocecal valve and the ileum.

The authors collected 52 cases in the literature. Although life in this condition is usually short, a number of patients have been seen in whom the anomaly was present in adult life. Surgical correction has been attempted in 2 cases. In both instances the heart was restored to the thoracic cavity and covered with skin flaps, but the sutures had to be released immediately because of the rapid embarrassment of the action of the heart.—*R. S. Bromer.*

Bromer, Ralph S. Role of the roentgenologist in the diagnosis of congenital cardiac lesions. *J. Am. M. Ass.*, Sept. 26, 1942, *120*, 251–254.

It is generally accepted that roentgen examination of the contours of the heart enables the examiner to observe the heart, its size, its position and in many cases its individual chambers. However, accurate diagnosis is dependent on complete clinical as well as roentgenologic findings. A knowledge of the normal roentgenographic image of the heart is most essential not only in the anteroposterior but also in the oblique and lateral projections. Ability to recognize the chambers is a primary requisite.

Congenital heart lesions are classified by Abbott as: (1) Acyanotic Group: This consists of cases in which no abnormal communication exists between the venous and arterial streams but in which mechanical interference with the circulation caused by the anomaly makes this the seat or point of cardiac strain. (2) Cyanose Tardive: In this group there is arteriovenous shunt with possible temporary or late reversal of flow, while cyanosis is absent except as a transient or terminal phenomenon. (3) Cyanotic Group: These are cases of permanent venous-arterial shunt and right-sided valvular lesions, with or without septal defects.

In 1939 Ash, Wolman and Bromer studied a series of 32 cases of congenital heart disease in infants which came to autopsy. Ash correlated the autopsy findings with the clinical and roentgenologic data. Wide variations in the roentgenographic picture in combined lesions in which two or more anomalies were present, as for example pulmonary stenosis in combination with other defects, were noted as was also the similarity of the roentgen picture in two or more different lesions.

Abbott states that the characteristic clinical picture of large interauricular septal defects or widely patent foramen ovale with dilated and hypertrophied right chambers has been established by the huge cardiac shadow, occupying chiefly the left side of the thorax with large pulmonary arc and narrow ascending aorta, combined with right axis deviation and physical signs absent or indefinite. But in Ash's series it was found that an increased width of the cardiac shadow to the right of the sternum in the anteroposterior view is most often caused by an enlarged right atrium which gives rise to the appearance of a globular heart situated in the midposition.

Taussig found that transposition of the great vessels was usually accompanied by hypertrophy of the right ventricle. In her 32 cases Ash found that of 8 cases with transposition of the great vessels there was hypertrophy of the left ventricle in 5 instead of the usually accepted finding of hypertrophy of the right ventricle. Taussig also found that in complete transposition of the great vessels the shadow of the aorta and the pulmonary artery at the base of the heart is narrowed in the anteroposterior plane, but is definitely broadened in the left oblique diameter. However, Ash found a narrow mediastinal shadow as noted in roentgenograms associated with transposed vessels in only 25 per cent of the cases of that group. More frequently the tremendously enlarged right auricular appendage projecting upward into the mediastinum caused widening of the mediastinal shadow on the right side.

Enlargement of the conus of the right ventricle is always associated with some degree of fullness in the median or pulmonic arc. This may at times be evidence of pulmonary stenosis, as the pulmonary artery, distal to a malformed, contracted ring, is often dilated and appears in the roentgenogram as an enlarged pulmonic arc. Enlargement of the low arc, left border of the heart, may be due to hypertrophy or enlargement of the left ventricle, but pronounced enlargement of this arc is not infrequently caused solely by hypertrophy of the right ventricle.

Bromer states briefly the roentgenographic features of the more usual cardiac defects of which a diagnosis is possible in infancy, including intraventricular septal defect (maladie de Roger), interauricular septal defect, pulmonic stenosis, tetralogy of Fallot, complete transposition of the great vessels, and patent ductus arteriosus.

The roentgenologist must make use of the facilities he possesses to the greatest advantageous degree. Changes in fluoroscopic apparatus for orthodiagraphy often cannot be made by the roentgenologist, but the teleroentgenogram can be used instead to supplement the fluoroscopic observations. The fluoroscopic examination in company with the referring cardiologist or pediatrician is most desirable. If the roentgenologist holds a hospital position he should attempt to attend postmortem examinations in all cardiac cases, should see the heart in situ when exposed on the autopsy table and should correlate the appearance of the heart and the size and shape of the chambers with his roentgenographic findings and thus learn from his personal observations the pathologic changes which have caused the abnormal contour of the heart.

Included in this article are copies of several roentgenograms illustrating various congenital cardiac lesions.—*S. G. Henderson.*

Levene, George, and Miller, Lois C. Roentgenologic appearance of the heart in toxic adenoma and Graves' disease. *Radiology*, May, 1942, *38*, 573–578.

The roentgen appearance of the heart varies greatly in thyrotoxicosis. In order to determine whether there is any characteristic change the authors studied a group of 96 cases and for comparison 26 patients with non-toxic adenoma of the thyroid and 100 persons without disease of the heart or thyroid.

They found three types of heart outline in cases of uncomplicated thyrotoxicosis. In the first the left border of the heart was a straight line. The lateral convexities caused by the pulmonary artery, the left auricle and left ventricle were decreased or absent. This type appears in the earliest and least severe cases. In Type II the left border of the heart was concave, particularly at the auriculoventricular junction. This was accentuated during deep inspiration. The pulmonary artery was prominent and projected laterally beyond the base of the heart. This was seen in cases of longer duration and greater severity than Type I. The third type was a normal outline, which was seen in the oldest and most severe cases.

Auricular fibrillation or decompensation was seen in all of these types. Generally the heart was not enlarged unless there was auricular fibrillation, congestive heart failure or associated heart disease.

In patients with uncomplicated thyrotoxicosis, thyroidectomy is followed by an increase in the transverse diameter of the heart. This would indicate that there is a decrease in the size of the heart during the disease. The heart is enlarged if the thyrotoxicosis is complicated by rheumatic, arteriosclerotic or hypertensive heart disease. The enlargement is reduced to a certain extent by thyroidectomy, as is also the enlargement of the heart which accompanies heart failure.

Compression of the trachea by an enlarged cervical or substernal thyroid does not cause enlargement of the heart.—*Audrey G. Morgan.*

Hild, Jack R. Calcification of arteries and deposits of calcium in both lungs in an infant. *Am. J. Dis. Child.* Jan., 1942, *63*, 126–130.

Occasional reports of extensive calcification of the arteries in infants have been reported in the literature. The case reported by Hild has the additional feature of widespread calcium deposition in the lungs. His patient was observed only during life and therefore the diagnoses were made from information obtained from the history, physical examination, laboratory procedures and roentgen studies. The patient was a girl, one year of age. The clinical picture was that of an infant whose growth and development were obviously retarded, with poor appetite, marked anemia, impaired renal excretion, marked azotemia and phosphatemia with resultant acidosis, extensive calcification of the arteries and widespread deposits of calcium in the lungs. On the negative side the kidneys could not be palpated, there was no roentgen evidence of renal calcification and there was a clearcut history of subminimal doses of vitamin D. Taking the age of the patient into consideration, Hild thinks the primary cause of the condition may well have been renal insufficiency due to congenital malformation of the urinary tract, possibly within the kidneys themselves. Hyperparathyroidism, either primary or secondary to renal insufficiency, and excessive amounts of vitamin D have also been mentioned frequently enough to be considered as possible causes of metastatic calcification, but no evidence of such etiologic factors were found in his patient.—*R. S. Bromer.*

Kaplan, Leo. Combined cod liver oil and liquid petrolatum pneumonia in a child. *Am. J. Dis. Child.*, Dec., 1941, *62*, 1217–1223.

Kaplan reports a case of combined cod liver

oil and liquid petrolatum pneumonia in a child of seventeen months. The identification of the oils after death and necropsy was made by a histochemical method utilizing sudan IV, nile blue sulfate, osmic acid and the Ziehl-Neelsen stain. He stresses the differential value of the biochemical method in the presence of cod liver oil pneumonia. The roentgenogram of his patient showed consolidation of the upper lobe of the right lung.—*R. S. Bromer.*

Carter, Ray A. Roentgen diagnosis of fungous infections of the lungs with special reference to coccidioidomycosis. *Radiology*, June, 1942, *38*, 649–659.

The roentgen appearances in the various fungous infections of the lung are quite similar to those of tuberculosis. But so many thousands of tuberculosis cases have been studied roentgenologically that the smallest details of the picture are familiar while comparatively few cases of coccidioidomycosis and other fungous diseases have been studied. The appearances in the different fungous diseases are very much alike, though the sites of predilection differ somewhat in the different diseases.

This study was made in the Department of Radiology of the Los Angeles County Hospital and special attention was devoted to San Joaquin Valley fever or infection with *Coccidioides immitis* which is prevalent in the San Joaquin Valley with secondary centers in Texas, Arizona and New Mexico. This disease is particularly characterized by enlargement of the mediastinal and hilar lymph nodes associated with various types of involvement of the parenchyma, massive, nodular or miliary, and various types of diffuse infiltration. The bones of the chest are also apt to be involved and this is a point that argues in favor of coccidioides infection rather than tuberculosis. Cavities are not so numerous as in tuberculosis. Other extrapulmonary lesions that are more apt to occur in fungous diseases than tuberculosis are enlargement of the superficial lymph nodes, superficial or deep soft tissue abscesses, granulomatous nodules, ulcers or sinuses from adjacent infections of the skin and meningitis. The recognition of such characteristic findings, as a basis for suspecting fungous disease, is perhaps more important than skill in roentgen differentiation between the different diseases for once that suspicion is aroused a search can be made for the specific organism involved in the case and the positive diagnosis still rests on the identification of the causative microorganism. Involvement of the mediastinum should always suggest the possibility of fungous disease.—*Audrey G. Morgan.*

Smith, Charles Edward. Parallelism of coccidioidal and tuberculous infections. *Radiology*, June, 1942, *38*, 643–648.

A study of San Joaquin fever, prevalent in the San Joaquin Valley in California, shows many similarities between this disease and tuberculosis. The tubercle bacillus is fungus-like, as indicated by the name *Mycobacterium tuberculosis*. Both the diseases enter the human body chiefly through the respiratory tract, though either may enter through abrasions of the skin. While tuberculosis may infect the intestine, coccidioidal enteritis is unknown. Both cause inflammation of the lungs and both show skin lesions in the form of erythema nodosum, which are a nonspecific manifestation of specific allergy. In either case the disease may become localized and calcification result.

Tuberculin and coccidioidin reactions are each specific for their own diseases but there are no specific reactions for the different strains of each organism and there does not seem to be any specific relation between the severity of the clinical disease and different strains of the organisms.

Erythema nodosum is more frequent in primary coccidioidomycosis than in primary tuberculosis. It rarely occurs after the primary stage of either disease. In both it occurs soon after allergy is established when the subject is hypersensitive.

Coccidioidal granuloma, the severe and often fatal secondary form of coccidioidomycosis, is evidently not due to external reinfection. There is abundant clinical and experimental proof of this. It is an endogenous infection from the primary focus. The primary infection does not predispose to granuloma, but on the contrary protects the patient from a second exogenous infection. Otherwise most of the residents in the San Joaquin Valley would have granuloma. Laboratory animals also are resistant to reinfection after the first infection.

Infection with *Coccidioides immitis* may become generalized and cause death in a short time. Illustrative cases are described. In this disease as well as tuberculosis the ability to localize the infection seems to depend on some unknown quality in the host, which may include such factors as sex and race.—*Audrey G. Morgan.*

Clemens, H. H., and Weens, H. S. Staphylococcic pneumonia in infants; occurrence of pneumopyothorax. *J. Pediat.*, March, 1942, *20*, 281–296.

Staphylococcic pneumonia in infants is a rare but severe disease. Pneumopyothorax is a frequent complication. It may be divided into primary and secondary groups. Primary groups occur through bronchogenic infection following infections of the upper respiratory tract such as sinus disease or middle ear infections. The secondary groups occur through lung infections which are metastatic following infections outside the respiratory tract.

The authors report 6 cases of primary staphylococcic pneumonia, 4 of which developed pneumopyothorax as a complication. All cases were treated with sulfonamide derivatives without clinical benefit and all terminated fatally. All cases were characterized by sudden onset, high fever, rapid respirations and marked toxicity.

The basis of the pneumopyothorax was formation of a bronchopleural fistula which followed rupture of an abscess. This complication occurred early in the course of the disease. There was nothing in the appearance of the chest roentgenograms to indicate the causative organism until the occurrence of the complication of pneumothorax. Frequent studies in the upright position are required to demonstrate this complication.—*R. M. Harvey.*

Adams, Ralph, and Davenport, Lowrey F. Technic of bronchography and a system of bronchial nomenclature. *J. Am. M. Ass.*, Jan. 10, 1942, *118*, 111–116.

Bronchography is an essential diagnostic aid in the investigation of many patients with cough and sputum. Every bronchial segment should be visualized in order that the extent of the disease may be established and a proper plan of therapy instituted.

Preoperative medication is beneficial in achieving abolition of cough, a suppression of mucous membrane secretions and proper introduction of oil. A small dose of pentobarbital one hour beforehand helps allay nervousness and acts as a specific prophylactic antidote to cocaine hypersensitivity. A dose of morphine sulfate one-half hour beforehand is useful for its effect in controlling the cough reflex. Atropine, given with the morphine, decreases the amount of secretion. It is important to have the bronchi empty by postural drainage accompanied by voluntary coughing three hours before injection. Thereafter the patient should neither eat nor drink until three hours after the procedure.

A sitting position should be used for the induction of local anesthesia to the throat and tracheobronchial tree. The authors' custom is to spray the pharynx with 3 cc. of 4 per cent cocaine, swab each piriform sinus and the epiglottis with 1 cc. and inject 5 cc. of 5 per cent larocaine down the trachea. A ureteral catheter is now threaded on a metal stylet, bent to an 80 degree angle 3 inches from the distal end. The laryngeal mirror is used and the catheter is introduced into the trachea and the stylet removed. The catheter should lie about 2 inches above the carina.

A series of positions is assumed as the injection proceeds which allows gravity filling of all bronchial subdivisions. The side of the chest suspected of disease should be examined first. A lateral roentgenogram of this side is made before oil is put into the other side of the chest. After both sides have been injected the authors make posteroanterior, posteroanterior with Lysholm grid, right anterior oblique and left anterior oblique roentgenograms. If the films are found satisfactory, the patient is placed in the head-down position and urged to cough up the iodized oil.

Cases of active pulmonary tuberculosis, acute lung abscess, intrinsic asthma and suspected tumor should not be investigated by means of iodized oil unless exceptional reasons exist for the procedure.

In the belief that a simple terminology, acceptable to a majority of workers in the thoracic field, is a primary condition for successful study and continued advance in the subject, Adams and Davenport propose classification designed to meet the practical needs of internists, radiologists, bronchologists and surgeons. The term primary bronchus is suggested for the two divisions of the trachea as preferable to main, major, arterial or trunk. The term division is proposed to indicate surgically and pathologically important anatomic portions of lobes. Thus, the left upper lobe has apical and lingular divisions and each lower lobe has dorsal and basal divisions. The right upper lobe may be thought of, if desired, as having only an apical division, while the right middle lobe possesses no divisional substructure.

The bronchopulmonary segment is defined as

a subdivision of the pulmonary lobe delimited by avascular, diverging planes which may or may not be indicated by complete or partial fissures. Its apex lies in the hilum and its base fills an area on the lung periphery. The right upper lobe is considered to consist of four segments, named anterosuperior, posterosuperior, anteroinferior and lateral. The right middle lobe consists of anteromedial and posterolateral segments. The lower lobe has two divisions, dorsal and basal. The dorsal division requires no subnames at this time. The basal division is characteristically divided into posteromedial, posterolateral, anteromedial and anterolateral segments. The left upper lobe has two divisions, one the lingular and one the apical. The lingula divides into anterolateral and posteromedial branches. The apical division separates into segments in a similar manner to the right upper lobe.—*S. G. Henderson.*

ABDOMEN

CURL, HOWARD. High fat diet preceding cholecystography; review of literature and experimental studies on filling normal gallbladder. *J. Am. M. Ass.*, June 20, 1942, *119*, 607–610.

Curl made gallbladder roentgen studies on 182 medical students, all subjects being free from any demonstrable digestive tract disease. Observations were made on various groups: (1) 103 students after a fat-free evening meal; (2) effect of a fat meal of cream and eggs on evacuating the dye-filled gallbladder, in 52 students; (3) the effect of a high fat diet for three days prior to administration of dye in 50 subjects; (4) in a similar number, the effect of a fat-free diet for three days before giving the dye; (5) an exclusive fruit diet for three days before the dye test in 25 individuals; (6) the effect of an exclusive fruit diet for three days after normal gallbladder visualization in 25 persons; (7) the effect of a high carbohydrate fat-free meal on emptying of the normal gallbladder in 50 students who had previously been on a general diet but who had had a fat-free meal prior to taking the dye; (8) the effect on a similar group in whom the only change was a high fat meal before the dye; (9) the effect of a lunch of their own selection in 37 students after normal filling of the gallbladder; (10) the effect of adding grape juice to the dye and, preceding the ingestion, giving of 1 drachm of paregoric to allay nausea and diarrhea in 70 students.

Tabulation of Results of Study of Gallbladders

Group		Number Examined	Number filled	Number not filled	Percentage not filled
1	Regular	103	74	29	28
2	Regular	52	52	Motor meal	100
3	High fat	50	43	7	14
4	Low fat	50	28	22	44
5	Fruit	25	14	11	44
6	Fruit	25	12	13	52
7	Low fat breakfast	50	37	13	26
8	High fat breakfast	50	41	9	18
9	Breakfast and lunch	37	37	10	27.7
10	Grapejuice and paregoric	70	58	12	17.14

The author believes that sufficient evidence has accumulated to warrant the suggestion that a high fat diet is indicated for a period of several days before cholecystic examination. He concludes that

1. Fat is an essential factor in the gallbladder emptying mechanism.

2. Patients on a fat free or low fat diet may have a gallbladder which, not emptied for days, may be distended with thick concentrated bile, and such a gallbladder, unable to admit more bile, will not be visualized on roentgen examination.

3. All patients whose gallbladder is examined routinely or who have a questionable or doubtful cholecystic history should be put on a high fat diet for several days or even weeks before the roentgen examination.—*S. G. Henderson.*

KING, ARTHUR B., and WAGHELSTEIN, JULIUS. Calcification of the pancreas. *Arch. Int. Med.*, Feb., 1942, *69*, 165–176.

The authors have found 11 cases in the literature in which they believe that diffuse calcification of the pancreas was definitely proved by chemical, roentgenological and pathological examinations. They add descriptions of 3 cases of their own, in a man of thirty-five, a Negro woman of thirty-five and a Negro woman of seventeen, and also 1 case recorded in the files of the Department of Pathology of Johns Hopkins Hospital in which the findings were so typical that they believe it was an authentic case, though no roentgen examinations or enzyme studies were made.

The symptomatology is not characteristic, the most common symptom being pain in the upper part of the abdomen not definitely localized. Positive diagnosis can be made only by roentgen demonstration of the calcium deposits.

Disturbances of carbohydrate metabolism are frequent. Two of the authors' patients had diabetes and the blood sugar curve of a third was abnormal.

Because of the extensive involvement of the pancreas no method of treatment is entirely satisfactory. If there is any evidence of pancreatic cyst or abscess surgical methods should be used. In one of the cases described a high carbohydrate diet proved helpful. Prognosis is good but there may be recurrent attacks of pain for years. When diabetes is present it is usually mild and can be controlled by small doses of insulin.—*Audrey G. Morgan.*

Berk, J. Edward, Rehfuss, Martin E., and Thomas, J. Earl. Method for the simultaneous aspiration of the contents of the stomach and the first part of the duodenum. *J. Am. M. Ass.*, May 16, 1942, *119*, 259–261.

In this article the authors describe a double-barrelled tube devised to supply a more satisfactory means of studying simultaneously the contents of the stomach and of the duodenal bulb. A soft rubber, double lumen tube was constructed with separate gastric and duodenal components modified from the type of tube used by Diamond and others in the study of pancreatic secretion. A small solid, stainless steel, non-perforated, bullet shaped tip, measuring 1.2 by 0.6 cm., was inserted into the free end of the single channel duodenal portion of the tube; 9.5 cm. ($3\frac{3}{4}$ in.) proximal to the tip, the duodenal limb was perforated over an area of 2.5 cm. in length; 6.5 cm. ($2\frac{1}{2}$ in.) orad to the most proximal duodenal performation the gastric limb was similarly perforated over an area 2.5 cm. in length. Radiopaque bands of stainless steel were placed immediately above and below both lengths of perforations.

The subject, following a twelve hour fast, was seated and the tube introduced through the mouth. When approximately 45 cm. of the tube had been swallowed the subject was placed before a vertical fluoroscope and the tube swallowed further until the metal tip was seen to point headward after sliding along the greater curvature of the stomach. In most instances the subject was next placed on the right side on a table adjacent to the fluoroscope and an additional 20 cm. of tube slowly swallowed during a period of twenty to thirty minutes, after the manner usually employed in duodenal intubation. The duodenal openings were assumed to be within the first part of the duodenum when the distal duodenal marker, as observed roentgenoscopically, was about 0.5 cm. below the apex of the bend in the duodenal tube. The tubes leading from the gastric and duodenal components were connected through separate Erlenmeyer flasks with a water suction bottle placed at such a height as to maintain a constant suction of 110 mm. of mercury.

The success of this method depends on the fact that anchorage of the tube is secured by having the small solid tip pass well into the second portion of the duodenum, where, in most persons, it remains steadfast.—*S. G. Henderson.*

Robbin, Lewis, and Bernhard, William A. Cystic fibrosis of the pancreas; report of a case, with clinical and pathologic observations. *Am. J. Dis. Child.*, March, 1942, *63*, 530–540.

Robbin and Bernhard report a case of cystic fibrosis of the pancreas in which the diagnosis was made clinically and was proved by autopsy. Cystic fibrosis of the pancreas must be primarily considered if, in an infant between birth and the age of six months, celiac symptoms occur either alone or complicated by a progressive infection of the respiratory tract with a paroxysmal cough simulating that of pertussis. In the patient reported in this paper the roentgenogram of the chest showed infiltration and a coarsely mottled appearance throughout the left lung and the upper portion of the right lung, very suggestive of bronchopneumonia.

Robbin and Bernhard describe a classification of chronic intestinal indigestion, chiefly from a clinical point of view and on the basis of response to therapy.

Diagnosis can be fortified by examination of duodenal contents for pancreatic enzymes. Absence, or a functionally deficient amount of these enzymes, as shown by Anderson's investigations, determines the nature of the disease. Completely diagnostic of cystic fibrosis of the pancreas is the association of the celioid symptoms with absence or a functionally deficient amount of trypsin in the pancreatic secretion. —*R. S. Bromer.*

Dow, James Findlay. Gastroscopic appearances in gastritis. *Brit. J. Radiol.*, Jan., 1942, *15*, 17–19.

Gastroscopists and roentgenologists rarely have an opportunity to see cases of acute gastritis and so for a description of this condi-

tion the author quotes the description given by William Beaumont of his servant Alexis St. Martin. He describes the eruptions or deep red pimples on the mucous lining of the stomach which are later filled with white purulent material.

The gastroscopist sees the three forms of chronic gastritis: superficial, atrophic and hypertrophic. In chronic superficial gastritis the mucous membrane is reddened, there is superficial edema and a mucopurulent exudate between the folds. The changes are usually most marked in the body of the stomach. The atrophic form may occur throughout the stomach or only in patches. The mucous membrane is pale gray and sterile looking or in advanced cases may even have a greenish tinge. The blood vessels of the submucosa, which cannot be seen in the normal stomach, shine through the mucosa. The folds are thin and may disappear completely when the stomach is distended. In hypertrophic gastritis the stomach lining is dull and thick or it may be warty and verrucose. Some areas show a cobblestone appearance and in severe cases there are erosions, small ulcers and hemorrhages. The folds are thick, stiff and rigid.

The relationship between these conditions remains obscure. The author has recently examined a series of cases in which roentgenologists had made a diagnosis of gastritis. The diagnosis was confirmed by gastroscopy in three-fourths of the cases, more than half of which were superficial gastritis and the others the hypertrophic form. There were no cases of atrophic gastritis, which suggests that this type cannot be diagnosed by roentgen examination. Further study should be made of the relationship between roentgen and gastroscopic findings.

For years there has been a large group of cases in which a clinical diagnosis of peptic ulcer has been made but roentgen examination has shown nothing. Close collaboration between roentgenologist and gastroscopist would doubtless serve to establish a diagnosis in these cases. —*Audrey G. Morgan.*

Berridge, F. R. The radiological aspect of gastritis. *Brit. J. Radiol.*, Jan., 1942, *15*, 1–10.

Forssell's work on the autoplastik of the gastric mucosa is reviewed. On the basis of roentgenological and histological study he attributes a power of independent movement to the mucosa of the digestive tract. This work was the basis for a roentgenologic study of gastritis.

In this article the author describes and illustrates with roentgenograms the normal and various pathological forms of gastric mucosa. In mild gastritis autoplastik is stimulated. There is a marked increase in the relief which is higher and coarser than normal. This cannot properly be called a hypertrophic gastritis for the fold formation is not due to thickening of the mucous membrane but to the condition of the submucosa. The folds are stiffer than normal and resist obliteration and straightening.

Changes in secretion also occur. Simple hypersecretion causes blurring of the mucosal pattern. The folds seem to be seen through a mist. Mucus causes the opaque medium to flocculate and gives the relief a granular appearance. The mucus fills the valleys between the folds and gives the inside of the stomach the appearance of a polished surface on which the medium runs together like mercury.

In advanced gastritis the autoplastik is depressed. In extreme cases there is no relief when the stomach is empty. In less advanced cases the relief is poor; the muscularis mucosae cannot produce normal resting relief. The mucous membrane in the contracted region is raised up irregularly.

Polypoid formation is seen in verrucose gastritis. These excrescences are brought about by true hyperplasia of the mucosa. Fibrosis of the deeper layers of the stomach shortens the lesser curvature and pulls the pylorus up to the ulcer, giving what is called on the Continent "snail rolling" of the stomach and what the author calls the "purse bag" stomach.

A gastritis can be diagnosed by roentgen examination but the chronic verrucose form is the only one in which the type of the disease can be stated. The roentgenogram shows only the resting relief of the stomach. The real classification of gastritis must be based on the anatomical findings and a special effort should be made to study the histological changes in resected material at some distance from the lesions. We have not as yet a complete picture of the pathology of gastritis.—*Audrey G. Morgan.*

Merchant, Albert K. Roentgen diagnosis of fungous infections of the gastro-intestinal tract. *Radiology*, June, 1942, *38*, 660–662.

The lungs and bones are much more frequently involved in fungous infections than the gastrointestinal tract. In fact they rarely occur below the mouth and above the cecum and

most of the relatively few cases reported are actinomycosis. Two cases are reported, one of actinomycosis of the duodenum and jejunum in which a diagnosis of obstruction of the pylorus by cancer was made from the roentgenogram; the other was a case of actinomycosis of the stomach in which a diagnosis of malignant chronic gastric ulcer was made. It is hardly possible to differentiate actinomycosis of the gastrointestinal tract from tuberculosis or cancer by roentgen examination.

The gastrointestinal tract is practically immune to blastomycosis but an unusual case of blastomycosis of the esophagus was reported in 1928 and is briefly reviewed here, as is also a case of infection of the intestine and peritoneum with *Oidium coccidioides.*—*Audrey G. Morgan.*

Walters, Waltman. Malignant lesions of the stomach. *Arch. Surg.*, April, 1942, *44*, 636–650.

The author reviews 11,000 cases of malignant lesions of the stomach seen at the Mayo Clinic from 1907 to 1938. Of these 6,352 were operated on and resection was performed in 2,840. Among the 6,352 patients operated on 110, or 1.7 per cent, had sarcoma.

The patients were living and well five years after operation in 28.9 per cent of the surgical cases, or in 31.9 per cent when the figure is adjusted for the normal death rate. This included all cases of whatever degree of malignancy.

Computed on the basis of Broders' index of malignancy which is determined by the comparative number of malignant and normal cells in a microscopic field, the five year survival rate was 86.2 per cent in cases of Grade 1, 58.8 per cent in Grade 2, 30.2 per cent in Grade 3 and 23.3 per cent in Grade 4.

It has generally been believed that the results of treatment of cancer of the stomach are much poorer in young patients than in old ones but this was not true in this group. The survival rate in patients under forty approximated that in the older ones. In all age groups females showed a higher rate of resectability and less operative risk than males.

Many patients with cancer have a type of dyspepsia that resembles that of ulcer and these are mistakenly diagnosed as benign ulcer. Unfortunately, they improve for a time under medical treatment and when the crater fills in with granulation tissue even roentgen examination frequently seems to indicate a benign lesion. This mistake has occurred in about 10 per cent of cases in which operation has been performed for cancer of the stomach.

Nor is a study of gastric acidity reliable in the diagnosis of cancer. About 20 per cent of the patients operated on for cancer had a free hydrochloric acid content of 30 degrees.

Though lesions of the stomach were demonstrated on roentgen examination in 98 to 99 per cent of these cases a definite diagnosis of cancer was made in only 75.3 per cent.

The author advocates the surgical removal of all chronic ulcers and benign polyps because of the possibility of malignant degeneration.

Cases operated on by the Billroth I method showed a higher five year survival rate than those operated on by the Polya method.—*Audrey G. Morgan.*

Stout, Arthur Purdy. Superficial spreading type of carcinoma of the stomach. *Arch. Surg.*, April, 1942, *44*, 651–657.

The author describes a superficial spreading type of cancer of the stomach which he had never seen until 1937. Since that time he has seen 15 cases. Growth starts superficially in the mucosa and submucosa and does not penetrate the muscularis until it has covered a large area. In only 5 of his 15 cases was there any involvement of the muscularis.

In this type of carcinoma there is reddening, irregularity and slight nodular thickening of the diseased mucosa. Generally there is a peptic ulcer from which the growth spreads outward. Sometimes there are islands of normal tissue between the diseased areas. The degree of differentiation of the cells varies greatly. In most of the cases there was fibrous thickening of the wall of the stomach and hypertrophy of the muscular coat. In all there was gastritis. Most of the patients had had symptoms of gastric or duodenal ulcer for from one to ten years. The difficulty was to determine whether they had gastritis, peptic ulcer or cancer.

It is possible that the reason for the sudden appearance and increase of this type of cancer lies in the fact that it has previously been diagnosed as peptic ulcer.

The results of partial gastrectomy have been gratifying. One patient died of cancer thirteen months after operation. Of the remaining 14 cases, 4 have survived operation for three years, 3 for between two and three years, 4 for be-

tween one and two years and 3 less than one year. All of them are free of symptoms.

Perhaps more careful study of patients with symptoms of peptic ulcer will show more cases of this type of cancer, which seems to yield readily to surgical treatment.—*Audrey G. Morgan.*

McGavran, Charles W. So-called mucous colitis or spastic irritable colon. *J. Am. M. Ass.*, Sept. 19, 1942, *120*, 182–184.

This is a condition due to a disturbance in the vegetative or autonomic nervous system. Although usually neurogenic in origin, often it is the result of irritation either in the gastrointestinal tract or in the organs adjacent to the gastrointestinal tract.

In the typical case the physical examination reveals an undernourished, asthenic individual. The colon, especially the sigmoid colon, is palpable, cordlike and tender. The cecum often is distended and tender. There may be generalized tenderness and distention. The characteristic stool consists of scybalous masses or ribbonlike stools covered with mucus. A complete gastrointestinal fluoroscopic and roentgenographic examination, including a barium enema, should be made. When no pathologic condition is demonstrated we have the picture of the spastic colon to show the patient as we explain our findings. The examination of the gallbladder should include roentgen study and a gallbladder drainage. In some instances it is necessary to make a complete urologic study.

If the study has shown organic disease, treatment is planned as indicated. Success in treating the neurogenic phase depends on gaining the confidence and cooperation of the patient. The history, the complete summary of the physical findings and their interpretation, and the diagnosis must be discussed with the patient. Sedatives and antispasmodics are given in quantities sufficient to quiet the general nervousness and relax the painful spasm in the colon until such time as the patient is able to control his symptoms. Diet is important in treating patients with a spastic colon, not so much in restricting them as in getting them to eat enough. There is usually a multiple deficiency and a multiple vitamin capsule is indicated. When laxatives are necessary liquid petrolatum, plain or combined with agar, often gives very satisfactory results.—*S. G. Henderson.*

Henderson, Richard G., Pinkerton, Henry, and Moore, Louis T. Histoplasma capsulatum as a cause of chronic ulcerative enteritis. *J. Am. M. Ass.*, March 14, 1942, *118*, 885–889.

Although originally believed to be a protozoon, recent studies of the organism, *Histoplasma capsulatum*, by DeMonbreun and others have shown that it is a yeast. The clinical picture of histoplasmosis is a variable one, being in general that of a chronic, febrile illness affecting all age groups and characterized by loss of weight, weakness, splenomegaly and generalized enlargement of the lymph nodes. In the case reported here the most prominent clinical feature was severe diarrhea, while the essential pathologic picture was an ulcerative colitis and terminal ileitis. At autopsy the terminal ileum, cecum and colon were involved in an ulcerative process. There were approximately thirty ulcers varying from 0.5 to 1.5 cm. in diameter, the long axis lying transversely and the lesions have sharp undermined edges.

Cases of histoplasmosis showing intestinal involvement are of importance because of their similarity to other types of ulcerative enteritis. This condition must be differentiated both clinically and pathologically from amebic and bacillary dysentery, tuberculous enteritis and, in certain cases, from idiopathic ulcerative colitis. The diagnosis depends, except in the latter instance, on the presence of a definite organism, which can be identified on smear or culture of the stool. In most cases of histoplasmosis with intestinal lesions the usual location is in the ileum or the colon. The typical lesions are ulcers, varying in size but eroding only the mucosa and submucosa. The bases of the lesions are granulomatous, showing numerous parasitized phagocytes. Tubercle-like lesions in the spleen and liver have been described in several reports but are not a constant finding. Their size and appearance have suggested sarcoid as well as tuberculosis.

The portal of entry appears to be a controversial point. The weight of evidence appears to be in favor of the gastrointestinal route, especially in those cases showing ulcerative lesions in the alimentary tract with mesenteric lymphadenopathy. It seems probable that almost every case of systemic infection occurs through the gastrointestinal tract with spread to the liver, spleen and lungs as a result of hematogenous or lymphohematogenous metastasis.—*S. G. Henderson.*

GENITOURINARY SYSTEM

McClelland, J. C., and Davis, K. F. Relationship between skeletal and genitourinary tuberculosis. *J. Urol.*, March, 1942, *47*, 320–322.

Bone tuberculosis and tuberculosis of the urinary tract are both secondary infections. The authors have studied 297 cases of bone and joint tuberculosis for possible urinary tuberculosis. Each patient had a culture of the urine for tubercle bacilli every four months. Patients with bladder symptoms were cystoscoped. Male patients were examined for involvement of the epididymis and seminal vesicles.

As a result of this study it was found that 18 per cent of cases of bone tuberculosis with a single bone lesion had genitourinary tuberculosis and 32 per cent of patients with multiple lesions of the bones had involvement of the genitourinary tract. In the series of 297 cases 22 per cent had genitourinary tuberculosis. Forty-one per cent of the cases studied had pulmonary tuberculosis and 35 per cent had no other demonstrable focus of tuberculosis than bone and joint lesions.

Genitourinary complications increased the mortality of bone and joint tuberculosis approximately 50 per cent.—*R. M. Harvey.*

Ballenger, E. G., and McDonald, H. P. Conservation of the hydronephrotic kidney. *J. Urol.*, March, 1942, *47*, 203–208.

The authors believe that many hydronephrotic kidneys are needlessly sacrificed. They feel that by a proper roentgen examination a causative diagnosis may be made in many of these cases and the obstructive lesion corrected by appropriate surgical means.

Obstruction at the ureteropelvic outlet associated with nephroptosis is a common etiological factor in the production of hydronephrosis. This obstruction is most often due to anomalous vessels, adhesive bands and fibrosis. The symptoms resulting from these lesions are vague and often misleading. The diagnosis can be established by ureteropyelograms made in the supine and upright positions.

The author's technique is to insert the catheter only 4 to 5 cm. up the ureter and inject the medium until the patient complains of fullness or discomfort. Roentgenograms are made in the supine and upright positions with the end of the catheter half way down the ureter. The upright roentgenogram is especially important in the detection of ptosis.

The correction of the obstruction in these cases is largely operative. It is important to fix the kidney mechanically if ptosis is present.—*R. M. Harvey.*

Sauer, H. R. Massive hydronephrosis; report of one case. *J. Urol.*, April, 1942, *47*, 416–420.

The author reports the case of a boy, aged sixteen, admitted to the hospital in severe shock. This came on three hours after a severe "belly-flop" dive into a lake. A survey roentgenogram of the abdomen was interpreted as showing free air underneath the left lobe of the diaphragm and a diagnosis of a ruptured hollow viscus was made. Operation revealed a large cystic mass in the left retroperitoneal area, 12 cm. in diameter. The cyst wall was incised and straw-colored fluid obtained.

Postoperatively the patient admitted having had a prior abdominal injury which was followed by pain, an abdominal mass and hematuria. Three days after the operation severe hematuria and left upper abdominal tumor mass appeared. A pyelogram showed displacement of the left ureter across the midline and an enormously enlarged upper calyx of the left kidney. The latter was the seat of a giant hydronephrosis which extended from the diaphragm to below the iliac crest.

A nephrectomy was performed and the hydronephrotic sac was found to contain 3,800 cc. of fluid.

The factors considered to be instrumental in the production of giant hydronephrosis are acquired, congenital, dynamic and traumatic. In the present case trauma is presumed to have aggravated a congenital condition by producing complete blocking of a partial obstruction.

The true diagnosis of giant hydronephrosis was frequently missed in the reported cases due to absence of symptoms directly referable to the urinary tract and also due to the rarity of the condition. Mistaken diagnoses were ovarian cyst, retroperitoneal cyst, echinococcus cyst of the liver and renal tumor.—*R. M. Harvey.*

Weisel, W., and Dockerty, M. B. Adenocarcinoma and fibrosarcoma in the same kidney; report of 2 cases. *J. Urol.*, April, 1942, *47*, 410–415.

The simultaneous occurrence of adenocarcinoma and fibrosarcoma in the same kidney is a rarity. The authors report 2 cases.

The first case was in a male, aged forty-eight, whose chief complaint was gross hema-

turia of two months' duration. An excretory urogram showed obstruction at the right ureteropelvic junction. A nephrectomy was done and adenocarcinoma found in the lower pole of the right kidney. Two months later symptoms recurred and six months later re-operation revealed a recurrence which proved to be sarcomatous histopathologically. A review of the original tumor showed that sarcomatous tissue was present at the time of the original operation although the main part of the tumor was hypernephroma.

The second case was a male, aged sixty-eight, who complained of pain and hematuria. These symptoms had first occurred seven years prior to the date of admission. Pathological examination of the left kidney after nephrectomy showed adenocarcinoma of the hypernephroma type and fibrosarcoma.—*R. M. Harvey.*

Goldberg, H., and Fowler, H. A. Pelvic single kidney; report of an additional case. *J. Urol.*, April, 1942, *47*, 440–443.

The solitary pelvic kidney is the rarest congenital anomaly of the upper urinary tract. Including the report of the present authors there are only 32 cases on record. All cases had anomalous blood supplies to the kidney, fixation of the kidney and short ureters.

The authors present a case in a male, aged fifty-one, who had no complains referable to the urinary tract. A retrograde pyleogram is shown demonstrating a single pelvic kidney. On cystoscopic examination only a single ureteral orifice was found. There was no interference with the function of the single kidney.—*R. M. Harvey.*

Davidson, O. W. Squamous-cell carcinoma of the renal pelvis. *J. Urol.*, March, 1942, *47*, 348–352.

The author presents a case of squamous carcinoma of the renal pelvis occurring in a female, aged sixty-two, and then discusses this relatively rare entity. A preoperative diagnosis has never been made. The onset is insidious and the course rapidly fatal.

The development of an epithelial tumor in a structure which originates from mesothelial and entodermal elements has been explained on the basis of metaplasia of the mucosa. The mucosa, with continual irritation, will undergo malignant changes.

All cases reported have been associated with chronic infection and 50 per cent of the cases with calculus disease. The symptoms are those of any renal tumor, hematuria, pain, and tumor mass.—*R. M. Harvey.*

Hamm, F. C. Wilms' tumor in a 64 year old male; report of a case. *J. Urol.*, April, 1942, *47*, 403–409.

Twenty-five cases of Wilms' tumor have been reported in adults. Adenosarcoma of the kidney is a very malignant tumor and no cases of survival have been reported in adults. The usual history is accidental discovery of an abdominal mass. Hematuria, renal colic, weight loss, dull pain in the flank, anorexia and malaise are other late symptoms.

These tumors are radioresponsive. Preliminary irradiation followed by nephrectomy and postoperative irradiation is the treatment of choice in children. In the adult preoperative irradiation is not feasible due to inability to diagnose the nature of the tumor.

Metastasis is to the local lymphatics, lungs and liver. Bone metastasis is rare.

The author adds the 26th reported case which occurred in a male, aged sixty-four, who complained of hematuria of six weeks' duration. Phenolsulfonphthalein test showed no function in the right kidney. Pyelographic examination showed obliteration of the lower calices of the right kidney and feathery outline of the upper calices. A diagnosis of renal tumor was made. A nephrectomy was done and pathological examination confirmed the diagnosis of Wilms' tumor.

The patient died two months after discharge from the hospital, no roentgen irradiation having been given.—*R. M. Harvey.*

Wharton, L. R. Simultaneous obstruction of both ureters, with uremia; report of 7 cases. *J. Urol.*, Feb., 1942, *47*, 133–140.

The author reports 7 cases of bilateral ureteral obstruction associated with uremia to show the causes, and mechanism in the various causes, the problems presented by the various causes, the problems of treatment and, finally, to emphasize the importance of recurrent pyelonephritis and ureteral obstruction which is the commonest cause of renal destruction.

Two cases were due to stricture of the ureters. The first patient showed no dye concentration on intravenous urography at twenty-five minutes and marked hydronephrosis of one kidney with contracture of the other at three hours. There was only 5 per cent phthalein ex-

cretion in fifteen minutes. The uremic manifestations disappeared with dilatation of the ureters. The second case was one of the end-results of a neglected pyelonephritis of infancy. The uremic symptoms were recurrent and could be controlled by ureteral dilatation. However, permanent renal damage has occurred.

In the third and fourth cases the obstruction was due to unsuspected urinary calculi resulting in sudden bilateral obstruction with uremia. The survey roentgenograms revealed no calculi in one case. In the second case the roentgenograms did show bilateral calculi but were misleading as to the condition of the two kidneys.

In the fifth case the obstruction was due to bladder atony and retention, without known cause. The 2 remaining cases showed obstruction due to cancer of the bladder and surgical ligation respectively.

The author concludes that chronic pyelonephritis may terminate in destruction of both kidneys. Incomplete stricture may be as serious as complete, and more difficult to recognize. It is essential to clear up urinary infection and obstruction before it progresses insidiously to permanent damage.—*R. M. Harvey.*

Johnson, C. M., and Smith, D. R. Benign polyps of the ureter. *J. Urol.*, April, 1942, *47*, 448–452.

One hundred and thirty-six cases of primary ureteral tumor had been reported up to 1937. The authors report a case in a twenty-four year old medical student who complained of pain in the left flank radiating to the left lower quadrant and the penis. The attacks had been present for eighteen years. Hematuria had occurred on one occasion. Pyelograms showed a left-sided hydronephrosis with an incompletely filled left ureter. Eighteen months later the hydronephrosis had increased and a definite filling defect was present in the upper portion of the ureter. This was diagnosed as a polyp. A nephrectomy and partial ureterectomy were performed. Two small pedunculated polyps were found.

The filling defect in the ureterogram is the only pathognomonic sign of ureteral polyp. The differential diagnosis includes all lesions causing renal pain, swelling and hematuria; i.e., renal tumor, injury, tuberculosis, and infarction.—*R. M. Harvey.*

Segal, A. D., and Fink, H. Cavernous hemangioma of the bladder. *J. Urol.*, April, 1942, *47*, 453–460.

The authors review the 40 previously reported cases of cavernous hemangioma of the bladder and add an additional case. The majority of cases occurred in patients under twenty years of age. Persistent hematuria was an almost constant feature of the histories. The amount of bleeding was not proportional to the size of the mass.

Biopsies may be misleading due to failure to obtain tissue from the deeper portions of the lesion. Nine cases had hemangiomata elsewhere in the body. Treatment consisted of fulguration, local excision, and radical resection. Apparent cures were obtained in 22 of the 40 cases.

The case reported by the authors was a boy, aged fifteen, who had had hematuria for eleven years. Cystoscopic examination showed a mass the size of a plum on the posterior bladder wall. Roentgenograms of the kidneys and ureter showed no abnormality. Cystogram and aerogram showed a filling defect in the bladder wall. A partial cystectomy was performed.

Cavernous hemangiomata are not to be confused with areas of enlarged tortuous vessels which occur in chronic infections and varicosities.—*R. M. Harvey.*

Conway, J. F., and Broders, A. C. Submucous extension of squamous cell epithelioma of the urinary bladder. *J. Urol.*, April, 1942, *47*, 461–471.

This article is based on the pathological study of more than 550 specimens of bladder tumor, removed both surgically and at necropsy. The authors found that it was impossible for the surgeon to tell from gross examination the extent of growth of a tumor beneath the submucosa and hence beyond its visible clinical limits.

On this account they believe that total cystectomy, with certain reservations, is the treatment of choice for tumors of Grades 3 and 4 and possibly for those of Grade 2. If segmented removal is done the edges of the resected specimen should be examined microscopically before the operation is completed. Also if segmental removal is contemplated it should be determined preoperatively that there is no roentgen evidence of metastasis to the chest and that the growth is limited to the bladder so far as can be determined by preoperative cystoscopic, cystographic, and intravenous urographic examination. An attempt should also be made to rule out gross evidence of metastasis to the liver, regional nodes and peritoneum.

The authors feel that roentgen therapy has little to offer in the treatment of epithelioma of the bladder.—*R. M. Harvey.*

Hueper, W. C., Fisher, C. V., de Carvajal-Forero, J., and Thompson, M. R. The pathology of experimental roentgen-cystitis in dogs. *J. Urol.*, Feb., 1942, *47*, 156–167.

The acute reaction which arises in the bladder following the use of roentgen rays or radium in a treatment of cancer of the uterus, prostate, bladder and rectum manifests itself as a catarrhal or hemorrhagic cystitis. It subsides usually in two to four weeks.

The late reactions are more insidious in onset, arise from three months to ten years after irradiation and may be focal or diffuse. This type of reaction may lead to sharply defined ulcers which heal by transformation into avascular scars, raspberry-like granulations which leave warty nodules after healing, or generalized induration and contraction of the bladder wall. These lesions, in addition to being serious complications, may resemble cancer or tuberculosis.

The authors irradiated 22 dogs for three successive days over the bladder area with the following factors: 135 kv. (peak); 5 ma.; 20–30 cm. distance; 7×7 cm. field; filter from 2 mm. Al to 0.25 mm. copper and 0.5 mm. Al; daily dosage 400 r and total dosage 1,200 r. The dogs were killed at varying intervals after irradiation and pathological studies were made of the bladder, urethra, ureter, prostate, rectum and testes.

In the bladder the following sequence of events was noted: edema of the submucosa, dilatation of the submucosal capillaries, vacuolization and pyknosis of the nuclei of the epithelial cells, lymphocytic infiltration of the submucosa, mucosal hemorrhages, development of epithelial cysts, desquamation of the epithelium and multiple small ulcerations. Later restitution of the vesical mucosa occurs. Epithelial cords may extend into the submucosa. Two of the 3 dogs, surviving ten to eleven months after irradiation, show an almost normal mucosa; however, intra-epithelial cysts persist. The third showed atrophic epithelium and fibrosis of the submucosa.

Similar changes were found in the other organs studied, with the exception of the urethra, which was in general normal. The authors found that the late changes were not due to an "endarteritic ischemia" but to "direct actinic epithelial necrosis aggravated by a subsequent bacterial infection." Apparently injury to the rectovesical septum allows fecal flora to penetrate into the bladder and induce a bacterial infection.—*R. M. Harvey.*

Lowsley, O. S., and Riaboff, P. J. Calcification of the vasa deferentia. *J. Urol.*, March, 1942, *47*, 293–298.

This is the 32nd case of calcification of the vas deferens reported in the literature. The authors summarize the previous case reports. In only a few of these was the diagnosis made by roentgen examination.

The cases reported have been divided into an inflammatory and a non-inflammatory group. The inflammatory type follows chronic infections such as tuberculosis or nonspecific chronic deferentitis or seminal vesiculitis. The non-inflammatory group occurs in elderly men and is due to senile changes in the muscularis.

The diagnosis is made by the roentgenogram and confirmed by vasography. The authors report a case in a male, aged sixty-seven, with calcified ampulla of the vasa deferentia confirmed by vasography.

Roentgenologists should consult this article and examine the illustrations in order to have a fixed picture of the lesion for future reference.—*R. M. Harvey.*

Adams, J. E. Study of malignant testicular tumors including case reports of chorionepithelioma accompanied by hypertension and teratoma testis with single tridermal metastases. *J. Urol.*, April, 1942, *47*, 491–507.

This article is based on a pathological study of 21 malignant tumors of the testicle. The usually accepted classification of testicular tumors is that proposed by Ewing:

1. Adult teratomas or embryomas which grow slowly.
2. Teratoid tumors which may contain derivatives of all three germ layers.
3. Embryonal tumors or seminomas.
4. Chorionepitheliomas which contain tissue similar to the trophoblastic tissue of the uterine chorionepithelioma.

Many tumors contain elements of more than one of these groups. The author gives the arguments supporting this classification of Ewing and also the arguments offered by other pathologists who feel that the seminomas should be separated from the teratoid tumors because they arise from specific cells lining the seminal tubules rather than from an overgrowth of car-

cinoma arising in epithelial elements of a teratoid tumor. The latter is the theory subscribed to by Ewing and others.

The author is led from the study of his own cases and those reported in the literature to feel that the majority of malignant testicular tumors, including seminomas, have a common origin.

Most authors agree that teratoma testis originates in the germinal epithelium and not in metaplasia as Virchow believed or in fetal inclusions.

The author includes a case report of a teratoma of the testis of ten months' duration in a male, aged twenty-nine. The right testicle was removed and 2,000 r was given postoperatively over the chest and abdomen. The patient died nine years later with widespread metastases of the para-aortic and mediastinal nodes and both lungs. The para-aortic nodes contained derivatives of all three germ layers.

The accepted theory of the origin of chorionepithelioma is that it arises from a teratoma which acts as an included ovum and produces true trophoblastic tissue in addition to more differentiated tissue. Testicular chorionepithelioma is rare. The author reports a case occurring in a male, aged twenty-two, with metastases to the lungs, abdomen, cervical nodes, liver and regional nodes. The interesting feature of the case was an associated hypertension. Hypertension was also found in this review in 4 other testicular tumors. This suggests, to the author, some relation between hypertension and the presence of gonadotropic hormone in the urine.

Finally, the author speculates whether the fact may not be true that trophoblastic tissue is present in teratoma of the testicle more frequently than is at present thought, and that the appearance of gonadotropic hormone in the urine in these cases is due to this trophoblastic tissue.—*R. M. Harvey.*

Friedman, H. H., and Grayzel, D. M. Myomatous tumors of the epididymis. *J. Urol.*, April, 1942, *47*, 475–481.

Primary tumors of the epididymis are a rarity. Of these sarcoma is the most common. Myoma is the most common benign tumor.

The authors report a case of myoma of the epididymis in a male, aged fifty-seven, who was admitted for a painless scrotal mass of four months' duration. An orchidectomy was performed and the epididymis was found to have been replaced by a firm tumor mass distinct from the testis. The latter was normal microscopically. The diagnosis of the tumor on histopathological examination was fibromyoma.

The authors summarize the 13 reported cases of myoma of the epididymis. The average age was 43.9 years. No definite predisposing factors were noted. The usual history was that of a painless slow-growing scrotal tumor which did not transmit light. The diagnosis has never been made preoperatively.

The origin of these tumors has not been settled. The treatment is epididymectomy and orchidectomy if the testicle is involved. There has been no case of recurrence and no instance of malignant degeneration.—*R. M. Harvey*